No. 2022-1493, -1547

United States Court of Appeals for the Federal Circuit

SISVEL INTERNATIONAL S.A.,
Appellant

v.

CRADLEPOINT, INC., SIERRA WIRELESS, INC.,
THALES DIS AIS DEUTSCHLAND GMBH,
Appellees

Appeals from the United States Patent and Trademark Office, Patent Trial and Appeal Board in IPR2020-01099

BRIEF FOR APPELLANTS

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Dated: June 30, 2022

1. A method of transmitting data in a radio system from a transmitter to a receiver, the method comprising:

> channel coding a data block into a coded data block by using a selected channel coding;
>
> puncturing the coded data block by using a first puncturing pattern; transmitting the coded data block punctured by the first puncturing pattern to the receiver;
>
> detecting a need for retransmission of the received coded data block;
>
> transmitting a retransmission request of the coded data block to the transmitter;
>
> increasing the code rate of the coded data block to be retransmitted by puncturing the coded data block coded by the channel coding of the original transmission using a second puncturing pattern including fewer symbols to be transmitted than the first puncturing pattern;
>
> transmitting the coded data block punctured by the second puncturing pattern to the receiver;
>
> combining the received coded data block punctured by the first puncturing pattern and the received coded data block punctured by the second puncturing pattern; and
>
> decoding the channel coding of the combined coded data block.

2. The method of claim 1, wherein the symbols to be transmitted of the first puncturing pattern and the second puncturing pattern together comprising as many of the symbols of the coded data block as possible.

3. The method of claim 1, wherein the code rate of the punctured coded data block does not exceed 1.

9. A radio transmitter comprising:

a channel coder for channel coding a data block into a coded data block by using a selected channel coding and for puncturing the coded data block by using a first puncturing pattern;

transmission means for transmitting the coded data block punctured by the first puncturing pattern to a receiver; and

means for receiving a retransmission request of the coded data block; wherein:

the channel coder increases the code rate of the coded data block to be retransmitted by puncturing the coded data block coded by the channel coding of the original transmission using a second puncturing pattern comprising fewer symbols to be transmitted than the first puncturing pattern;

the transmission means transmit the coded data block punctured by the second puncturing pattern to the receiver.

CERTIFICATE OF INTEREST

Counsel for Appellants certifies the following:

1. The full names of every party represented by me are:

Sisvel International S.A.

2. The names of the real parties in interest represented by me are:

N/A.

3. Parent corporations and publicly held companies that own 10% or more of stock in the party:

Fineur International S.A.

4. The names of all law firms and the partners and associates that have appeared for the party in the agency or are expected to appear for the party in this Court and who are not already listed on the docket for this case are:

Devlin Law Firm LLC: Timothy Devlin, Neil Benchell, Stephanie Berger, and Andrew DeMarco

5. This Court's decision in this appeal may directly affect the following pending cases:

Sisvel Int'l S.A. v. Xirgo Techs., No. 19-cv-01145 (D. Del.);

Sisvel Int'l S.A. v. VeriFone Sys., Inc., No. 19-cv-01144 (D. Del.);

Sisvel Int'l S.A. v. Cradlepoint, Inc., No. 19-cv-01142 (D. Del.);

Sisvel Int'l S.A. v. Honeywell Int'l, Inc., No. 19-cv-01143 (D. Del.);

Sisvel Int'l S.A. v. Ford Motor Company, No. 21-cv-01745 (D. Del.)

6. This case involves no organizational victims or bankruptcy cases.

Dated: June 30, 2022

/s/ Timothy Devlin
Timothy Devlin

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STATEMENT OF RELATED CASES

Under Fed. Cir. R. 47.5(a), counsel for Appellant Sisvel International S.A., ("Appellant"), certifies that no other appeal from the same proceeding in the United States Patent and Trademark Office ("PTO" or "Patent Office"), Patent Trial and Appeal Board ("PTAB" or "the Board"), is or was previously before this Court or any other appellate court, whether under the same or a similar title.

Under Fed. Cir. R. 47.5(b), counsel for Appellant states that the Court's decision in this appeal may affect the following judicial and administrative matters:

Sisvel Int'l S.A. v. Xirgo Techs., No. 19-cv-01145 (D. Del.);

Sisvel Int'l S.A. v. VeriFone Sys., Inc., No. 19-cv-01144 (D. Del.);

Sisvel Int'l S.A. v. Cradlepoint, Inc., No. 19-cv-01142 (D. Del.);

Sisvel Int'l S.A. v. Honeywell Int'l, Inc., No. 19-cv-01143 (D. Del.);

Sisvel Int'l S.A. v. Ford Motor Company, No. 21-cv-01745 (D. Del.)

JURISDICTIONAL STATEMENT

This appeal is from the PTAB's final written decision ("FWD"), issued January 18, 2021, in Case No. IPR2020-01099, finding claims 1-3, and 9 (the "invalidated claims") of U.S. Patent No. 6,529,561 ("the '561 patent") unpatentable. Appellant filed a timely notice of appeal under 35 U.S.C. §§ 141-142 and 37 C.F.R. § 90.2 on February 23, 2022. (D.I. 1-2.) This Court has jurisdiction under 28 U.S.C. § 1295(a)(4)(A) and 35 U.S.C. § 141(c).

I. STATEMENT OF THE ISSUES

1. Was the Board's ruling in its Final Written Decision arbitrary and capricious when it decided that the prior art disclosed the use of a first and second data puncturing, which is not supported by substantial evidence,

2. Was the Board's ruling in its Final Written Decision arbitrary and capricious when it decided that Chen disclosed combining coded data blocks, even though the Board failed to set forth a sufficiently detailed explanation of its determinations?

II. STATEMENT OF THE CASE

Sisvel appeals the Board's rulings that invalidated claims 1-3 and 9 (the "invalidated claims") of U.S. Patent No. 6,529,561 B2 ("the '561 patent") as obvious based on the Chen reference. (Appx00059-060.) Patent Owner does not dispute that Chen is prior art to the '561 patent.

The key disputes in this appeal relate to the faulty reasoning underlying the Board's ruling in the Final Written Decision, or the lack of articulated reasoning in the Final Written Decision. Specifically, the Board found that the Chen reference disclosed data puncturing—a technique used throughout the '561 patent—despite evidence presented by Patent Owner that data puncturing is a wholly different technique than that disclosed in Chen. (Appx0021-22, 00308, 00483-484, 02540-02542, 02603-604, 02614-2616.) Patent Owner demonstrated that Chen

specifically endorses a technique known as "interleaving" which is different from the concept of "combining" disclosed and claimed by the '561 patent. Patent Owner provided evidence that the difference between these two methods would have been readily understood by a POSITA reading the Chen reference. (Appx00566, 02541-42, 02542.) Indeed, there is evidence in the record that Chen teaches away from combining. (Appx02542.)

In finding that the Chen reference disclosed the element of combining two received coded data blocks punctured by a first and second puncturing pattern, respectively, the Board ignores expert testimony. Patent Owner provided expert testimony indicating that a POSITA would understand Chen's "interleaving" method to be distinct from the '561 patent's "combining" due to operating in completely different manners and achieving different ends. (Appx02538-42; *see also* Appx02603-604.) Moreover, Patent Owner identified sections in Chen demonstrating that interleaving is a completely separate technique from combining (contrary to the Board's decision), and that interleaving is preferred. (Appx0000297, 00483, 00571-572.) Despite the above, the Final Written Decision spares a single sentence from the Board indicating that it is "not persuaded" by the express language of the Chen reference or Patent Owner's expert with no further elaboration. (*See* Appx00037.)

Because the Final Written Decision goes against the weight of substantial evidence, it is therefore capricious and arbitrary. Further, the Final Written Decision offers no guidance regarding the element of "combining," and so it does not allow for meaningful judicial review as to that element.

Accordingly, Patent Owner respectfully requests that the Board's Final Written Decision be vacated and these proceedings be remanded to the PTAB to allow the Board to make further findings and to provide "a sufficiently detailed explanation of its determinations . . . to enable meaningful judicial review. *Rovalma, S.A. v. Bohler-Edelstahl GmbH & Co. KG*, 856 F.3d 1019, 1024 (Fed. Cir. 2017).

III. STATEMENT OF THE FACTS

A. The Patented Technology

The '561 patent is a U.S. national stage filing of international application no. PCT/FI00/00755, filed on September 7, 2000. (Appx00143.) The '561 patent pertains to a method and apparatus of transmitting data in a radio system such that user data throughput is increased while decreasing transmission delays and data loss. (Appx00151; Appx002537.) To accomplish this objective, the '561 patent employs methods of puncturing and incremental redundancy to assist in channel coding. (Appx00152; Appx002537.)

Channel coding, generally, is a technique for ensuring that data transmitted

from a transmitter to a receiver arrives intact and uncorrupted. (Appx00154; 02536.) To accomplish this, the technique tacks on additional bits of data to a "coded data block" to ensure detection and correction of errors. (Appx02536.) Transmitting this additional information, however, as the consequence of drawing on additional network resources. (Appx02536.)

"Incremental Redundancy" or "IR" is a technique wherein a receiver stores coded data blocks in its memory, and in the event of errors, combines retransmitted data blocks with the originally transmitted data block to assist in decoding. (Appx02536.) In this way, detections of errors at a receiver can decrease the number of wholly redundant retransmissions of an entire data block by storing data as required to remedy damage occurring during transmission. (Appx02536-537.)

More specifically, the '561 patent is directed to correcting these data blocks that become damaged during transmission as described above. (Appx02537-538.) The claimed method uses a second puncturing pattern to "puncture-out" only the data needed to correct errors at the receiver-end, and retransmitting that data for combination with the compromised original data block at the receiver that had been subjected to a first, different puncturing pattern, resulting in increased network efficiency. (Appx02537-538.) By puncturing both the original transmission and the retransmission data blocks at increasing code rates

respectively, an improved level of redundant information for data integrity is maintained while increasing the amount of data transmitted during use of network resources. (Appx02537-538.)

The ’561 patent further teaches a “combining” process in which the information obtained from retransmission is collated with the originally transmitted data block to make it whole again. (Appx02537-538.) The process of “combining” the two data blocks allows a UE to perform error correction while maintaining optimal use of network availability, as the second puncturing pattern on the retransmission ensures that only the data needed to make the originally transmitted data block whole is retransmitted. (Appx02537-538.) The ’561 patent’s innovation is an improvement over concepts such as interleaving, which require the retransmission of the entire original data block, and thus may put unnecessary strain on network availability. (Appx02537-538.)

B. The Claims at Issue

Petitioner challenged the validity of all claims of the ’561 patent. (Appx00186.) The Board found only claims 1-3 and 9 unpatentable, on the grounds that the claims were obvious in light of Chen. (Appx0059-61.) Claims 1 and 9 are independent claims; claims 2 and 3 depend from claim 1. (Appx00156.)

Claim 1 is reproduced below:

> 1. A method of transmitting data in a radio system from a transmitter to a receiver, the method comprising:

> channel coding a data block into a coded data block by using a selected channel coding;
>
> puncturing the coded data block by using a first puncturing pattern;
>
> transmitting the coded data block punctured by the first puncturing pattern to the receiver;
>
> detecting a need for retransmission of the received coded data block;
>
> transmitting a retransmission request of the coded data block to the transmitter;
>
> increasing the code rate of the coded data block to be retransmitted by puncturing the coded data block coded by the channel coding of the original transmission using a second puncturing pattern including fewer symbols to be transmitted than the first puncturing pattern;
>
> transmitting the coded data block punctured by the second puncturing pattern to the receiver;
>
> combining the received coded data block punctured by the first puncturing pattern and the received coded data block punctured by the second puncturing pattern; and
>
> decoding the channel coding of the combined coded data block.

(Appx00156.)

Claim 9 is reproduced below:

> 9. A radio transmitter comprising:
>
> a channel coder for channel coding a data block into a coded data block by using a selected channel coding and for puncturing the coded data block by using a first puncturing pattern;
>
> transmission means for transmitting the coded data block punctured by the first puncturing pattern to a receiver; and
>
> means for receiving a retransmission request of the coded data block; wherein:

> the channel coder increases the code rate of the coded data block to be retransmitted by puncturing the coded data block coded by the channel coding of the original transmission using a second puncturing pattern comprising fewer symbols to be transmitted than the first puncturing pattern;
>
> the transmission means transmit the coded data block punctured by the second puncturing pattern to the receiver.

(Appx00156.)

C. Prior Art at Issue—Chen

International Patent Publication No. WO 99/26371, entitled "Method and apparatus for time efficient retransmission using symbol accumulation" ("Chen") describes a method and apparatus for retransmission of data using interleaving, or "symbol accumulation," in a CDMA environment. (Appx01200.) In particular, Chen advocates for the "interleaving" or "accumulating" of coded data blocks which are not punctured (i.e., have coded data bits removed prior to transmission) at two different code rates but are encoded from the outset at different code rates. (Appx01204; Appx01215; Appx01219.)

As discussed above, the '561 patent claims recite "combining" data blocks punctured by two puncturing patterns. Chen teaches "interleaving" blocks, which would have been recognized by a POSITA as different from combining. (Appx 02541-42, Appx02542.) In fact, Chen explicitly disclaims ***combining*** in favor of ***interleaving***: "[a]t the receiver, the code symbols for the retransmitted packets are

interleaved (not combined) with the corresponding code symbols from prior transmissions."[1] (Appx01200.)

IV. SUMMARY OF THE ARGUMENT

The Board's ruling in the Final Written Decision was arbitrary and capricious for at least two reasons. First, in deciding that Chen discloses the use of a second puncturing pattern, the Board drew its conclusion contrary to the weight of evidence which indicates that Chen does not disclose puncturing whatsoever, much less the use of a second puncturing pattern. Second, the Board failed to set forth a sufficiently detailed explanation of its determination that Chen discloses combining to enable meaningful judicial review and prevent judicial intrusion on agency authority, as required by the Federal Circuit. *See, e.g., Rovalma* at 1024.

First, the Board's determination that Chen's method of encoding code blocks at different code rates discloses the '561 patent's method of data puncturing goes against the substantial weight of evidence. Patent Owner provided uncontroverted expert testimony that data puncturing is a procedure where coded data bits are removed from a coded data block. (Appx02536; Appx02602; Appx02613.) The sole embodiment relied on by Petitioner concerns only a method of encoding data blocks at two different code rates, not using two different puncturing patterns to alter the code rates of an original and retransmitted data block. (Appx02602.) In

[1] Unless otherwise noted, all emphasis in this brief is added.

light of this substantial evidence, a ruling that Chen discloses the use of a second puncturing pattern must be considered arbitrary and capricious.

Second, the Board's Final Written Decision fails to address arguments which Patent Owner raised in its Response and Sur-Reply—arguments which Patent Owner identified had been left wholly unrebutted by Petitioner in those same briefs. Specifically, Patent Owner provided unrebutted expert testimony that the technique of interleaving would be understood by a POSITA to refer to a particular kind of retransmission involving the use of matrices to spread-out errors during a transmission—not, as Petitioner asserts, a technique of combining data blocks or "accumulating symbols." (Appx02621-622; *see* Appx00572.) Indeed, Patent Owner identified specific instances within the Chen reference where Chen delineates between "combining" and its process of "interleaving," stating that blocks are to be "interleaved (***not combined***)." (Appx00483-84; Appx00571.) Petitioner's arguments, adopted by the Board in its Final Written Decision, that interleaving is simply a more precise definition or subset of combining is ***directly belied*** by the distinction that Chen draws above—wherein in additional ***rejects*** the technique of combining. (Appx0036-37.)

The Final Written Decision acknowledges these arguments, but merely states that the Board does not find them persuasive without further explanation.

(Appx0037-38.) This conclusory determination fails to provide the basis for meaningful judicial review. *See, e.g.*, *Rovalma* at 1024.

V. ARGUMENT

A. Standards of Review Section

This Court reviews decisions by the Board according to the standards of review set forth in the Administrative Procedure Act ("APA"). *In re Chapman*, 595 F.3d 1330, 1336-37 (Fed. Cir. 2010). Accordingly, this Court reviews the Board's legal conclusions *de novo* and its factual findings for substantial evidence. *Id.*; *see* 5 U.S.C. § 706(2); *see also Rambus Inc. v. Rea*, 731 F.3d 1248, 1251 (Fed. Cir. 2013); *Ariosa Diagnostics v. Verinata Health, Inc*., 805 F.3d 1359, 1364 (Fed. Cir. 2015); *Chemours Co. FC, LLC v. Daikin Indus*., 4 F.4th 1370, 1374 (Fed. Cir. 2021).

Obviousness is a question of law based on underlying findings of fact. *Chemours* at 1374; *see also In re NuVasive, Inc*., 842 F.3d 1376, 1381 (Fed. Cir. 2016). "What the prior art teaches, whether a person of ordinary skill in the art would have been motivated to combine references, and whether a reference teaches away from the claimed invention are questions of fact." *Id.* (*citing Meiresonne v. Google, Inc*., 849 F.3d 1379, 1382 (Fed. Cir. 2017)).

When considering whether a PTAB finding meets the substantial evidence standard, the Court considers whether a reasonable factfinder could have arrived at

the decision. *Pers. Web Techs., LLC v. Apple, Inc.*, 848 F.3d 987, 991 (Fed. Cir. 2017). Substantial evidence requires more than a "mere scintilla" and must be enough such that a reasonable mind could accept the evidence as adequate to support the conclusion. *Chemours* at 1374 (*citing Consol. Edison Co. v. NLRB*, 305 U.S. 197, 229, 59 S. Ct. 206, 83 L. Ed. 126 (1938)). The Court reverses when a PTAB factual finding about the disclosures of the prior art is not based on substantial evidence. *See Institut Pasteur v. Focarino*, 738 F.3d 1337, 1345 (Fed. Cir. 2013).

"We review the Board's decisions under the Administrative Procedure Act (APA). Taking 'due account . . . of the rule of prejudicial error,' we must 'hold unlawful and set aside agency action, findings, and conclusions found to be . . . arbitrary, capricious, an abuse of discretion, or otherwise not in accordance with law,' 'without observance of procedure required by law,' or 'unsupported by substantial evidence.' 5 U.S.C. § 706. In applying those standards, 'we will uphold a decision of less than ideal clarity if the agency's path may reasonably be discerned,' but 'we may not supply a reasoned basis for the agency's action that the agency itself has not given.'" *Rovalma, S.A. v. Bohler-Edelstahl GmbH & Co. KG*, 856 F.3d 1019, 1024 (Fed. Cir. 2017) (*citing Bowman Transp., Inc. v. Ark.-Best Freight Sys., Inc.*, 419 U.S. 281, 285-86, 95 S. Ct. 438, 42 L. Ed. 2d 447 (1974); *SEC v. Chenery Corp.*, 332 U.S. 194, 196-97, 67 S. Ct. 1575, 91 L.

Ed. 1995 (1947)). "Thus, the Board must, as to issues made material by the governing law, set forth a sufficiently detailed explanation of its determinations both to enable meaningful judicial review and to prevent judicial intrusion on agency authority." *Id.*; *see SEC v. Chenery Corp*., 318 U.S. 80, 88, 94, 63 S. Ct. 454, 87 L. Ed. 626 (1943); *Personal Web Technologies, LLC v. Apple, Inc*., 848 F.3d 987, 991-93 (Fed. Cir. 2017); *In re NuVasive, Inc*., 842 F.3d 1376, 1382-83 (Fed. Cir. 2016).

"A decision is arbitrary and capricious when the agency fails to articulate a 'rational connection between the facts found and the choice made.'" *In re Vivint, Inc*., 14 F.4th 1342, 1351 (Fed. Cir. 2021) (*citing Motor Vehicle Mfrs. Ass'n of U.S., Inc. v. State Farm Mut. Auto. Ins. Co*., 463 U.S. 29, 43, 103 S. Ct. 2856, 77 L. Ed. 2d 443 (1983)).

B. The Board's Decision was Arbitrary and Capricious and Not Supported by Substantial Evidence

1. The Board's Finding that Chen Disclosed the Use of a Second Puncturing Pattern is not Supported by the Evidence

The claims of the '561 patent require that a received coded data block punctured by a first puncturing pattern is combined with a received coded data block punctured by a second puncturing pattern. (Appx00156.) The Board's determination that Chen discloses data puncturing at all, let alone a using first ***and*** second puncturing pattern, goes against the substantial weight of the evidence.

Further, the Board fails to sufficiently describe the rationale for finding that Chen discloses combining despite significant evidence to the contrary.

a. Chen's selective retransmission method does not constitute data puncturing

The Final Written Decision states that "we are persuaded that 'a POSITA at the relevant priority date would have understood that Chen's teachings to ***selectively transmit*** only a subset of the convolutional encoder's output ***is*** data puncturing.'" (Appx00028) (emphasis in original.) But this determination is not supported by the evidence.

Petitioners argued that Chen's method of simply encoding a data block at a particular code rate constitutes data puncturing. (Appx00028.) Patent Owner provided expert testimony to the contrary:

> At 14:13-24 of Chen, what the reference is disclosing is the use of differing amounts of generators during the encoding step to achieve a differing code rates [*sic*] among transmissions and retransmissions alike. Indeed, this makes sense in context as Chen is discussing how a "convolutional encoder is designed for the necessary code rate." (Ex. 1003 at 13:28-30.) Chen is discussing the means by which an encoded data block is created with different ratios of redundant data bits, not methods of changing those ratios in the encoded data blocks once encoded by removing redundant data bits. ***Simply encoding a data block at a code rate does not constitute puncturing, which—as acknowledged by the '561 patent—is the removal of encoded data bits from a coded data block.*** (*See*, Ex. 1001 at 7:35-39; 7:46-47.)

(Appx02601-602.) The ’561 patent is explicit—data puncturing is not simply encoding at a different code rate, but removing data bits from an already encoded data block:

> Next, in block 504, ***the coded data block 402 is punctured*** using a first puncturing pattern 404. Puncturing refers to ***removal coding***, i.e. a procedure where the number of coded symbols is decreased ***by removing a certain number of symbols***. The symbols ***to be removed*** can be defined by a puncturing pattern.

(Appx00154.)

Petitioner’s own expert agreed. In his declaration, Dr. Kakaes stated that “puncturing is a technique for tailoring the code rate of a transmission ***by selectively removing coded data bits (or symbols) from the coded data block***.” (Appx00922-23.) Dr. Kakaes repeated this in his deposition, stating that data puncturing is “a technique for tailoring the code rate of a particular transmission. In other words, tailoring which bits are transmitted, ***and you do that by selectively removing coded data bits from the set of coded data block***.” (Appx02613.)

Despite all of this testimony, the Board merely noted that it agrees with Petitioner’s expert that “Chen’s selective transmission (i.e., puncturing) of the output from only certain generators is also consistent with the only embodiment of the ’516 patent[.]” (Appx00030-31).) The Board ignores the substantial evidence regarding this difference in technique, focusing instead on alleged similarities between code rates—rates that Petitioner and the Board concede are different. (*See*

Appx00031) (noting that the Chen encodes from a 1/4 convolutional encoder, whereas the ’561 patent encodes from a 1/3 convolutional encoder.) The Board’s determination thus ignores the substantial weight of evidence regarding Chen’s failings to disclose data puncturing.

b. Chen teaches away from the use of a second puncturing pattern

Weighing further against Chen disclosing the use of a second puncturing pattern, Chen teaches away from the use of data puncturing entirely. As the Board notes in the Final Written Decision, a reference teaches away when a person of ordinary skill “upon reading the reference, would be discouraged from following the path set out in the reference, or would be led in a direction divergent from the path that was taken” by the claimed invention. (Appx00034 (citing *Galderma Labs., L.P. v. Tolmar, Inc.*, 737 F.3d 731, 738 (Fed. Cir. 2013) (internal quotations omitted).)

While Chen discloses that puncturing, generally, may be of use, it complains that “[p]uncturing reduces the number of code symbols to be retransmitted ***but also reduces the correcting capability of the convolutional code.***” (Appx01214.) The Final Written Decision notes that Chen also discloses that code rates can be generated using punctured codes, but warns against it, as above. (Appx00034.) This is not a mere “tradeoff,” as the Board suggests, but here Chen is suggesting that this method is not preferred.

2. The Board's Finding that Chen's Interleaving Method Discloses the '561 Patent's Combining Insufficiently Detailed

"[T]he Board must, as to issues made material by the governing law, set forth a sufficiently detailed explanation of its determinations both to enable meaningful judicial review and to prevent judicial intrusion on agency authority." *Rovalma* at 1024. Here, the Board failed to provide a "sufficiently detailed explanation" for its rejection of Patent Owner's arguments of nonobviousness for the reasons set forth below, and thus the Final Written Decision below does not enable meaningful judicial review. *See Rovalma* at 1024. The Final Written Decision is therefore arbitrary and capricious and should be vacated, with these proceedings remanded to the PTAB for further consideration and clarification.

In its discussion about the Board's determination that Chen disclosed the element of ***combining*** the first received coded data block with the second coded data block, the Board merely sets forth the parties' arguments, restates that in the Institution Decision the Board found Dr. Kakaes' testimony persuasive, and then claims that "[e]ven having considered Patent Owner's arguments in its Response and Sur-Reply and having considered Mr. Bates' Declaration and deposition testimony and the entire record developed during trial, we find Patent Owner's arguments unavailing." (Appx00037.) The Board provides no further explanation except to restate some of its same findings from the institution decision with no

explanation or analysis. In so doing, the Board failed to address the many arguments put forth in the Patent Owner in Patent Owner's Response and Sur-Reply, after the Institution Decision was made. (*See* Appx00483-84; Appx00571-575.)

The Board's decision is void of any analysis of Patent Owners post-Institution arguments, many of which are addressed above. For example, the Board reiterates its preliminary determination that "a POSITA would understand that 'interleaving' is a more specific description of the method of the '561 patent described in Figure 4, which the '561 patent refers to as combining," despite the overwhelming evidence provided by Patent Owners that Chen specifically rejects combining in favor of interleaving (Appx00035-36.) Another example involves Owner's expert describes the difference between the two methods as a POSITA at the time of invention would have understood them. (Appx02621-622.) These arguments and discrepancies go unaddressed by Petitioners and the Board.

The Board also adopts its prior preliminary determination from the Institution Decision that Chen's alternate method—accumulating packets—also constitutes "combining." (Appx00037-38.) Yet Patent Owner rebutted this argument in its Response (Appx00484.), which the Board fails to address in its Final Written Decision. (Appx00037-38.) In fact, Petitioners themselves call this

very method "interleaving," which Chen ***expressly*** distinguishes from combining and roundly rejects. (Appx00532.)

Patent Owner also noted in its response that the packet accumulation method disclosed in Chen fails to discuss accumulating packets of two coded data blocks subjected to different puncturing patterns. This is a required element of the '561 patent claims. (Appx00532.) The only reference made by the Board to Patent Owner's arguments was that the Board found them "unavailing." Missing is any explanation ***why*** they were unavailing.

By providing no explanation beyond a conclusory statement of disbelief in Patent Owner's considerable evidence, the Board fails to "set forth a sufficiently detailed explanation of its determinations . . . to enable meaningful judicial review" (*Rovalma* at 1024) or to "articulate a rational connection between the facts found and the choices made" (*Vivint* at 1351) regarding its final determination. *See also TRUSTID, Inc. v. Next Caller, Inc*., App. Nos. 2020-1950 and 2020-2028, 2021 U.S. App. LEXIS 29136 at *24 (Fed. Cir. Sept 27, 2021) (non-precedential) ("Here, the Board merely partially reiterated and summarily rejected [the party's] arguments without explanation. This is not sufficient under the [Administrative Procedure Act] and our precedent.").

Accordingly, Patent Owner respectfully requests that the Final Written Decision be vacated and the proceedings be remanded to the PTAB for further

consideration and clarification.

VI. CONCLUSION

For the foregoing reasons, the Court should vacate the Board's Final Written Decision as arbitrary and capricious and remand those proceedings to the PTAB for further consideration and clarification of the material issues appealed herein.

Dated: June 30, 2022

Respectfully submitted,

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CERTIFICATE OF COMPLIANCE

Pursuant to 37 C.F.R. § 42.24(d), the undersigned certifies that there are 3,990 words in this paper, excluding any table of contents, table of authorities, mandatory notices under 37 C.F.R. § 42.8, certificate of word count, certificate of service, or appendix of exhibits. This certification relies on the word count of the word-processing system used to prepare this paper.

/s/ Timothy Devlin
Timothy Devlin

CERTIFICATE OF SERVICE

I hereby certify that on June 30, 2022, I caused a copy of this document to be served by transmitting it via e-mail or electronic transmission to Appellees' counsel of record.

/s/ Timothy Devlin
Timothy Devlin

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571-272-7822

Paper 51
Entered: January 18, 2021

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

CRADLEPOINT, INC.,
SIERRA WIRELESS, INC., and
THALES DIS AIS DEUTSCHLAND GMBH,
Petitioner,

v.

SISVEL INTERNATIONAL S.A.,
Patent Owner.

IPR2020-01099
Patent 6,529,561 B2

Before BARBARA A. PARVIS, AMANDA F. WIEKER, and MONICA S. ULLAGADDI, *Administrative Patent Judges.*

ULLAGADDI, *Administrative Patent Judge.*

JUDGMENT
Final Written Decision
Determining Some Challenged Claims Unpatentable
35 U.S.C. § 318(a)

I. INTRODUCTION

Cradlepoint, Inc., Dell Inc., Sierra Wireless, Inc., Thales DIS AIS Deutschland GmbH, ZTE Corporation, and ZTE (USA) Inc. filed a Petition requesting an *inter partes* review of claims 1–10 of U.S. Patent No. 6,529,561 B2 (Ex. 1001, "the '561 patent"). Paper 6 ("Pet."). As ZTE Corporation and ZTE (USA) Inc. have entered into a settlement agreement with Sisvel International S.A. ("Patent Owner") Patent Owner resolving their disputes concerning the '561 patent, we terminated these entities from the proceeding. Papers 34, 35, 36; Ex. 2009. Based on similar filings, we also terminated Dell Inc. from the proceeding. Papers 47, 48, 49; Ex. 2010. In this Decision, we collectively refer to the remaining entities—Cradlepoint, Inc., Sierra Wireless, Inc., and Thales DIS AIS Deutschland GmbH—as "Petitioner."

Sisvel International S.A. ("Patent Owner") filed a Preliminary Response. Paper 10 ("Prelim. Resp."). We instituted an *inter partes* review on all challenged claims on all grounds set forth in the Petition. Paper 11 ("Institution Decision" or "Inst. Dec.").

Patent Owner thereafter filed a Response to Petition (Paper 25, "PO. Resp."), Petitioner filed a Reply (Paper 30, "Pet. Reply"), and Patent Owner filed a Sur-Reply (Paper 33, "PO Sur-Reply"). An oral hearing was held on October 19, 2021, and a transcript of the hearing (Paper 50, "Tr.") has been entered into the record.

II. BACKGROUND

A. Related Proceedings

The parties identify the following matters related to the '561 patent:

Sisvel International SA et al. v. ZTE (USA), Inc. et al., Case No. 3:19-cv-01694 (N.D. Tex.) (filed July 15, 2019);

Sisvel International SA v. Dell Inc., Case No. 1:19-cv-01247 (D. Del.) (filed July 1, 2019);

Sisvel International SA v. AnyData Corporation, Case No. 1:19-cv-01140 (D. Del.) (filed June 20, 2019);

Sisvel International SA v. Blu Products, Inc., Case No. 1:19-cv-01141 (D. Del.) (filed June 20, 2019, transferred to S.D. Fla. as Case No. 1:20-cv-20813);

Sisvel International SA v. Cradlepoint, Inc., Case No. 1:19-cv-01142 (D. Del.) (filed June 20, 2019);

Sisvel International SA v. Honeywell International, Inc., Case No. 1:19-cv-01143 (D. Del.) (filed June 20, 2019);

Sisvel International SA v. Verifone Systems, Inc., Case No. 1:19-cv-01144 (D. Del.) (filed June 20, 2019);

Sisvel International SA v. Xirgo Technologies, LLC, Case No. 1:19-cv-01145 (D. Del.) (filed June 20, 2019);

Sisvel International SA et al. v. Tesla, Inc., Case No. 1:19-cv-02288 (D. Del.) (filed Dec. 17, 2019);

Sisvel International S.A. v. Blu Products, Inc., Case No. 1:20-cv-20813 (S.D. Fla.) (filed Feb. 25, 2020); and

u-blox AG et al. v. Sisvel International SA et al., Case No. 3:20-cv-00494 (S.D. Cal.) (filed Mar. 16, 2020). Pet. 2; Paper 7, 1–2.

B. The '561 Patent

The '561 patent is titled "Data Transmission in Radio System" and concerns the application of differing puncturing patterns to an original transmission of a coded data block and to a retransmission of the coded data block. Ex. 1001, codes (54), (57). The '561 patent discloses channel-coding a data block to obtain a coded data block "by using a selected channel

coding." *Id.* at 7:21–22. In the example depicted in Figure 4, coded data block 402 has a code rate of 1/3 because each data symbol has three corresponding channel-coded symbols. *Id.* at 7:23–25.

Coded data block 402 is punctured by removing a certain number of channel-coded symbols according to first puncturing pattern 404. *Id.* at 7:34–39. The '561 patent exemplifies first puncturing pattern 404 with bits 011011011. *Id.* at 7:39–40. The '561 patent explains that "[t]he 0 bit denotes that the channel-coded symbol located at the point in question is removed, while the 1 bit is not removed." *Id.* at 7:40–42. Punctured coded data block 408 punctured by first puncturing pattern 404 is transmitted, in an original transmission, to a receiver. *Id.* at 7:46–48. Thus, the original transmission comprises the second, third, fifth, sixth, eighth, and ninth channel-coded symbols, because the first, fourth, and seventh symbols are removed by the first puncturing pattern (i.e., as denoted by the 0 bits in the puncturing pattern). *Id.* at 7:49–52.

When the receiver is unable to decode coded data block 408, a retransmission request is transmitted to the transmitter. *Id.* at 7:55–56, 60–61. The receiver's capability to decode is detected "either by an error detection code or by the fact that an error correcting code cannot correct errors occurring on the channel with sufficient certainty." *Id.* at 7:56–59. The '561 patent discloses that "the code rate of the coded data block to be retransmitted is increased . . . by puncturing the coded data block 402" using second puncturing pattern 406. *Id.* at 8:4–8. Second puncturing pattern 406 removes more symbols than first puncturing pattern 404. *Id.* at 8:8–10. The '561 patent discloses that, "[i]n the example of FIG. 4, the second puncturing pattern 406 comprises bits 100100100," which determines that "only the first and the third symbol thereafter are retained, while other

symbols are removed." *Id.* at 8:10–13. In the example, "the punctured and coded data block 410 used in this retransmission comprises symbols 101, i.e. the first, fourth, and seventh symbol of the original channel-coded block 402." *Id.* at 8:17–20.

Next, "the received coded data block 408 punctured by the first puncturing pattern 404 and the received coded data block 410 punctured by the second puncturing pattern 406 are combined," which is possible because "both [coded] data blocks 408, 410 are punctured versions of the same coded data block 402." *Id.* at 8:21–26. In the example of Figure 4:

> The second, third, fifth, sixth, eighth and ninth symbol of a combined coded data block 412 are obtained from the coded data block 408 punctured by the first puncturing pattern 404, and the first, fourth and seventh symbol are obtained from the coded data block 410 punctured by the second puncturing pattern 406.

Id. at 8:26–32. Finally, combined coded data block 412 is decoded using, for example, a Viterbi decoder. *Id.* at 8:42–43.

C. Challenged Claims

Petitioner challenges claims 1–10 of the '561 patent. Claim 1, 5, 9, and 10 are independent. Independent claims 1 and 10 are reproduced below.

> 1. A method of transmitting data in a radio system from a transmitter to a receiver, the method comprising:
>
> channel coding a data block into a coded data block by using a selected channel coding;
>
> puncturing the coded data block by using a first puncturing pattern;
>
> transmitting the coded data block punctured by the first puncturing pattern to the receiver;
>
> detecting a need for retransmission of the received coded data block;
>
> transmitting a retransmission request of the coded data block to the transmitter;

> increasing the code rate of the coded data block to be retransmitted by puncturing the coded data block coded by the channel coding of the original transmission using a second puncturing pattern including fewer symbols to be transmitted than the first puncturing pattern;
>
> transmitting the coded data block punctured by the second puncturing pattern to the receiver;
>
> combining the received coded data block punctured by the first puncturing pattern and the received coded data block punctured by the second puncturing pattern; and
>
> decoding the channel coding of the combined coded data block.

Ex. 1001, 11:24–49.

> 10. A radio receiver comprising:
>
> reception means for receiving a coded data block channel coded by a selected channel coding and punctured by a first puncturing pattern;
>
> a channel decoder for decoding the received coded data block;
>
> means for detecting a need for retransmission of the received coded data block; and
>
> means for transmitting a retransmission request of the coded data block to a transmitter;
>
> wherein:
>
> the reception means receive the retransmitted coded data block whose code rate has been increased by puncturing the coded data block coded by the channel coding of the original transmission by using a second puncturing pattern comprising fewer symbols to be transmitted than the first puncturing pattern;
>
> the reception means includes means for combining the received coded data block punctured by the first puncturing pattern and the received coded data block punctured by the second puncturing pattern;
>
> a channel decoder decodes the channel coding of the combined coded data block.

Id. at 13:1–14:12.

D. Asserted Grounds of Unpatentability

Petitioner challenges claims 1–10 as follows. *See* Pet. 7.

Claims Challenged	35 U.S.C. §[1]	Reference(s)/Basis
1–3, 5–7, 9, 10	§ 102	Chen[2]
1–3, 5–7, 9, 10	§ 103	Chen
1–10	§ 103	Chen, Eriksson[3]
1–10	§ 103	Chen, GSM 03.64[4]

Petitioner relies on the First and Second Declarations of Dr. Apostolos Kakaes (Exs. 1002, 1023) as well as the Declarations of Mr. Craig Bishop (Ex. 1007) and Mr. Gerard Grenier (Ex. 1008) in support of the contentions in the Petition.

Patent Owner relies on the First and Second Declarations of Mr. Regis Bates (Exs. 2001, 2005) in support of its contentions.

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[1] The Leahy-Smith America Invents Act ("AIA"), Pub. L. No. 112-29, 125 Stat. 284, 285–88 (2011), amended 35 U.S.C. § 102 and § 103, effective March 16, 2013. Because the application from which the '561 patent issued was filed before this date, the pre-AIA version of § 102 and § 103 applies.

[2] World Intellectual Property Organization Patent Application No. PCT/US98/24155, filed Nov. 12, 1998, Publication No. WO 99/26371, published May 27, 1999, to Tao Chen et al. (Ex. 1003, "Chen").

[3] S. Eriksson et al., "*Comparison of Link Quality Control Strategies for Packet Data Services in EDGE*," 1999 IEEE 49th Vehicular Technology Conference, May 16–20, 1999 (Ex. 1004, "Eriksson").

[4] Special Mobile Group of the European Telecommunications Standards Institute ("ETSI"), Global System for Mobile Communications (GSM) Technical Specification (TS) 101 350 V8.0.0 (1999–07), "Digital cellular telecommunications system (Phase 2+); General Packet Radio Service (GPRS); Overall description of the GPRS radio interface; Stage 2," GSM 03.64, Version 8.0.0, Release 1999 (Ex. 1005, "GSM 03.64").

III. ANALYSIS

A. Principles of Law

"In an [*inter partes* review], the petitioner has the burden from the onset to show with particularity why the patent it challenges is unpatentable." *Harmonic Inc. v. Avid Tech., Inc.*, 815 F.3d 1356, 1363 (Fed. Cir. 2016) (citing 35 U.S.C. § 312(a)(3) (requiring *inter partes* review petitions to identify "with particularity . . . the evidence that supports the grounds for the challenge to each claim")). This burden of persuasion never shifts to Patent Owner. *See Dynamic Drinkware, LLC v. Nat'l Graphics, Inc.*, 800 F.3d 1375, 1378 (Fed. Cir. 2015) (discussing the burden of proof in *inter partes* review).

As set forth in 35 U.S.C. § 103(a),

> [a] patent may not be obtained . . . if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains.

The question of obviousness is resolved on the basis of underlying factual determinations including: (1) the scope and content of the prior art; (2) any differences between the claimed subject matter and the prior art; (3) the level of ordinary skill in the art; and (4) when in evidence, objective evidence of nonobviousness. *Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966). An obviousness analysis "need not seek out precise teachings directed to the specific subject matter of the challenged claim, for a court can take account of the inferences and creative steps that a person of ordinary skill in the art would employ." *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 418 (2007); *accord In re Translogic Tech., Inc.*, 504 F.3d 1249, 1259 (Fed. Cir. 2007). However, Petitioner cannot satisfy its burden of proving obviousness by

employing "mere conclusory statements." *In re Magnum Oil Tools Int'l, Ltd.*, 829 F.3d 1364, 1380 (Fed. Cir. 2016). Instead, Petitioner must articulate a reason why a person of ordinary skill in the art would have combined the prior art references. *In re NuVasive*, 842 F.3d 1376, 1382 (Fed. Cir. 2016). The scope of the prior art includes all analogous art. *Donner Tech., LLC v. Pro Stage Gear, LLC*, 979 F.3d 1353, 1359 (Fed. Cir. 2020).

We analyze the asserted ground of unpatentability in accordance with these principles to determine whether Petitioner has met its burden to demonstrate by a preponderance of the evidence that the challenged claims are unpatentable.

B. Level of Ordinary Skill in the Art

Petitioner does not present a definition for the level of ordinary skill in the art in its Petition. *See generally* Pet. In his Declaration, Dr. Kakaes testifies that:

> A POSITA [person of ordinary skill in the art] at the time of the alleged invention (September 10, 1999) would have had a degree in electrical engineering or a similar discipline, with at least three years of relevant industry or research experience, including designing or implementing cellular radio systems for data transmission and retransmission. A POSITA would also have familiarity with the GSM standard and the EGPRS [Enhanced General Packet Radio Service] enhancement.

Pet. 37–38 (citing Ex. 1002 ¶¶ 15–25).

In its Patent Owner's Response, Patent Owner states:

> [A] person having ordinary skill at the time of invention—September 10, 1999—in the relevant art would be one with a bachelor's degree in electrical engineering or computer sciences and telecommunications networks, along with at least three or more years of practical experience in the field. A combination

> of more experience in the field and less education or more education and less experience in the field would also suffice.

PO Resp. 7 (citing Inst. Dec. 9; Ex. 2001 ¶ 27).

Although there are differences between the contentions of the parties as to the level of ordinary skill in the art, the parties have not informed us of a dispute that needs to be resolved. We do not find it necessary to resolve the differences between the contentions of the parties as to the appropriate level of ordinary skill in the art because the findings and conclusions rendered in this Decision do not turn on either proposed definition. We determine, on this record, that the level of ordinary skill proposed by Patent Owner is consistent with the ’561 patent and the asserted prior art. As such, we adopt Patent Owner’s proposed definition for a person of ordinary skill in the art.

C. Claim Construction

For cases like this one, where the petition for *inter partes* review was filed after November 13, 2018, we interpret claim terms in accordance with the standard used in federal district court in a civil action involving the validity or infringement of a patent. *See* 37 C.F.R. § 42.100(b) (2019).

Claim limitations that include the terms “means” or “means for” are presumed to invoke 35 U.S.C. § 112 ¶ 6. *See Williamson v. Citrix Online, LLC*, 792 F.3d 1339, 1348 (Fed. Cir. 2015) (en banc in relevant part). Claims subject to 35 U.S.C. § 112 ¶ 6 are construed in a “two-step process,” whereby we “first identify the claimed function,” and then “determine what structure, if any, disclosed in the specification corresponds to the claimed function.” *Id.* at 1351. Accordingly, the rules governing this *inter partes* review require that Petitioner “identify the specific portions of the specification that describe the structure, material, or acts corresponding to

each claimed function." 37 C.F.R. § 42.104(b)(3). It is well established that "the corresponding structure for a § 112 ¶ 6 claim for a computer-implemented function is the algorithm disclosed in the specification." *Aristocrat Techs. Austl. Pty Ltd. vs. Int'l Game Tech.*, 521 F.3d 1328, 1333 (Fed. Cir. 2008) (quoting *Harris Corp. v. Ericsson Inc.*, 417 F.3d 1241, 1249 (Fed. Cir. 2005)); *see also EON Corp. IP Holdings, LLC v. AT&T Mobility LLC*, 785 F.3d 616, 623 (Fed. Cir. 2015) ("A microprocessor or general purpose computer lends sufficient structure only to basic functions of a microprocessor. All other computer-implemented functions require disclosure of an algorithm.").

Petitioner proposes a construction for the term "code rate." Separately, with regard to means-plus-function limitations recited in claims 5, 9, and 10, Petitioner provides claim construction contentions that identify the specific portions of the specification that describe the structure, material, or acts corresponding to each claimed function, as required by 37 C.F.R. § 42.104(b)(3). Pet. 33–37. Patent Owner does not propose a definition for any claim term nor does it contest any of Petitioner's proposed constructions. PO Resp. 7–9.

In the Institution Decision, we preliminarily construed the means-plus-function claim limitations as set forth in the table below, but determined that it was not necessary for us to construe the claim term "code rate." Inst. Dec. 11–20 (citing *Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.*, 868 F.3d 1013, 1017 (Fed. Cir. 2017)).[5] Based on the

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[5] Petitioner notes that "construction may be helpful to establishing the inverse and counterintuitive relationship between code rate and redundancy in which an ***increased*** code rate (*e.g.*, 1/2) means that ***fewer*** redundant bits are transmitted whereas a decreased code rate (*e.g.*, 1/4) means that ***more***

entirety of the record developed during trial, we maintain our preliminary determination that we need not expressly construe "code rate" and our preliminary determinations for the means-plus-functions terms for the reasons set forth in our Institution Decision, which we adopt and do not repeat herein, and which are reflected in the table below. *Id.* at 11–19. Because Petitioner presents further argument for its construction of "means for detecting" in its Petitioner's Reply—we address that argument below for completeness.

Limitation	Function	Corresponding Structure
"transmission means for transmitting the coded data block punctured by the [first/second] puncturing pattern to [the/a] receiver" (claims 5, 9)	transmitting the coded data block punctured by the first puncturing pattern to [the/a] receiver and transmit[ting] the coded data block punctured by the second puncturing pattern to the receiver	a modulator modulating digital signals to a radio frequency carrier wave and equivalents thereof
"means for detecting a need for retransmission of the received coded data block" (claims 5, 10)	detecting a need for retransmission of the received coded data block	insufficient algorithmic structure identified
means for transmitting a retransmission request of the coded data block to [the/a] transmitter" (claims 5, 10)	transmitting a retransmission request of the coded data block to [the/a] transmitter	radio transmitter and equivalents thereof

redundant bits are transmitted." Pet. Reply 6 (citing Ex. 1002 ¶¶ 52–56, 224–227; Ex. 1024, 39:14–40:22, 41:22–42:7). According to Petitioner, "so long as this relationship is borne in mind, it ultimately should make no difference to the Board's decision whether an express construction is adopted or not." *Id.*

Limitation	Function	Corresponding Structure
"means for combining [a/the] received coded data block punctured by the first puncturing pattern and [a/the] received 10 coded data block punctured by the second puncturing pattern" (claims 5, 10)	combining a received coded data block punctured by the first puncturing pattern and a coded data block punctured by the second puncturing pattern	symbol combination software executed in a processor or hardware and equivalents thereof
"means for receiving a retransmission request of the coded data block" (claim 9)	receiving a retransmission request of the coded data block	radio receiver demodulator and equivalents thereof
"reception means for receiving a coded data block channel-coded by a selected channel coding and punctured by a first puncturing pattern"/"reception means [to] receive the retransmitted coded data block" (claim 10)	receiving the coded data block channel-coded by the selected channel coding and punctured by the first puncturing pattern and "receiv[ing] the retransmitted coded data block"	radio receiver demodulator and equivalents thereof

During the oral hearing, Petitioner introduced *EnOcean v. Face International*, 742 F3d 955, 959 (Fed. Cir. 2014) and asserted that, in *EnOcean*, the relevant question for a means-plus-function term, in particular a "means for receiving," is "whether it connotes sufficiently definite structure to those of skill in the art." Tr. 10:1–7, 12–15. Petitioner further argued that the record in this proceeding contains "undisputed testimony in the record from both of the declarants that a POSITA would have understood the algorithm connoted by the forward error correction [(FEC)] software as well as the [cyclic redundancy check (CRC)] error detection

software" is corresponding structure for the recited "means for detecting." *Id.* at 10:8–11.

Petitioner's reliance on *EnOcean* is untimely and inapposite. On appeal to the Federal Circuit, "EnOcean challenge[d] the Board's determination that its receiver claims invoke § 112, ¶ 6," citing external evidence *and* expert testimony and arguing that "the claim limitation 'receiver' is reasonably well understood in the art as a name for a structure which performs the recited function." *EnOcean*, 742 F.3d at 959 (citing *Greenberg v. Ethicon Endo–Surgery, Inc.*, 91 F.3d 1580, 1583 (Fed. Cir. 1996) (applying this test to the claim term "detent mechanism")). "Face respond[ed] by arguing that the claimed 'receiver' is defined only in terms of the function that it performs (i.e., receiving), not its structure" and that "a receiver is 'essentially a black box that performs a recited function,' because 'how it does so is left undisclosed.'" *Id.* (citing *Blackboard, Inc. v. Desire2Learn, Inc.*, 574 F.3d 1371, 1383 (Fed. Cir. 2009)). The Court held that "[t]he term 'receiver' (i.e., the absence of the term means) presumptively connotes sufficiently definite structure to those of skill in the art." *Id.* (citing *Personalized Media Commc'ns, LLC v. Int'l Trade Comm'n*, 161 F.3d 696, 703–04 (Fed. Cir. 1998)). The Court explained that "Face has not overcome that presumption" finding that "the record indicates that the term 'receiver' conveys structure to one of skill in the art—the Board itself made a factual finding that that the 'skilled worker would have been familiar with the design and principles of the types of components utilized in the claimed invention, including . . . receivers.'" *Id.*

Thus, in *EnOcean*, the Court addressed whether EnOcean had successfully overcome the presumption that a claim limitation *lacking* the term "means" connotes sufficiently definite structure and, accordingly,

invokes treatment under 35 U.S.C. § 112, 6th paragraph. Here, by contrast, the "means for detecting" limitation explicitly recites the term "means", such that we *start* with a presumption that 35 U.S.C. § 112, 6th paragraph applies. The converse presumption addressed in *EnOcean* is not applicable. Petitioner does not show, or attempt to show, that the presumption that "means for detecting" invokes 35 U.S.C. § 112, 6th paragraph is or should be overcome.

In the present proceeding, Petitioner contends that "Patent Owner's [D]eclarant testified that a POSITA would be sufficiently familiar with the well-known and commonly used error detection codes, such as the [cyclic redundancy check (CRC)] check [sic] . . . ." Pet. Reply 5 (citing Ex. 1024, 106:17–107:16). Patent Owner's Declarant also testified to a POSITA's familiarity with the Automatic Repeat Request (ARQ) protocol and hybrid ARQ. Ex. 1024, 106:17–107:16. According to Petitioner, "[t]he record therefore has sufficient evidence that a POSITA would have known from the '561 specification how to program a processor or hardware to achieve the claimed function of 'detecting a need for retransmission of the received coded data block.'" *Id.* at 5–6 (citing Pet. 34; Ex. 1002 ¶ 203).

We recognize, however, "the testimony of one of ordinary skill in the art cannot supplant the total absence of structure from the specification." *Default Proof Credit Card Sys., Inc. v. Home Depot U.S.A., Inc.*, 412 F.3d 1291, 1302 (Fed. Cir. 2005); *see also Biomedino, LLC v. Waters Techs. Corp.*, 490 F.3d 946, 950–53 (Fed. Cir. 2007). "The prohibition against using expert testimony in this manner is a direct consequence of the requirement that the specification itself adequately disclose the corresponding structure." *Noah Sys., Inc. v. Intuit Inc.*, 675 F.3d 1302, 1312 (Fed. Cir. 2012) (citing *AllVoice Computing PLC v. Nuance Commc'ns.,*

Inc., 504 F.3d 1236, 1240 (Fed. Cir. 2007)). "[T]his court has consistently required that the structure disclosed in the specification be more than simply a general purpose computer or microprocessor." *Aristocrat Techs. Austl. Pty Ltd. v. Int'l Game Tech.*, 521 F.3d 1328, 1333 (Fed. Cir. 2008). The specification must "disclose an algorithm for performing the claimed function." *Net MoneyIN, Inc. v. VeriSign, Inc.*, 545 F.3d 1359, 1367 (Fed. Cir. 2008); *Aristocrat*, 521 F.3d at 1333. The Federal Circuit has held that "[t]he specification can express the algorithm 'in any understandable terms including as a mathematical formula, in prose, or as a flow chart, or in any other manner that provides sufficient structure.'" *Noah*, 675 F.3d at 1312 (citing *Finisar Corp. v. DirecTV Grp., Inc.*, 523 F.3d 1323, 1340 (Fed.Cir.2008) (internal citation omitted)). "Simply disclosing software, however, 'without providing some detail about the means to accomplish the function[,] is not enough.'" *Id.* (citing *Finisar*, 523 F.3d at 1340–41 (citation omitted)).

In the present proceeding, even assuming, *arguendo*, that the record sufficiently supports a finding that a POSITA would have known of FEC, CRC, ARQ, and hybrid ARQ protocols, Petitioner has not shown that the specification of the '561 patent discloses a sufficient algorithm, whether "as a mathematical formula, in prose, or as a flow chart, or any other manner that provides sufficient structure" for the "means for detecting," including an algorithm for performing any one or more of these protocols. *Noah*, 675 F.3d at 1312.

The '561 patent discloses "means (224) for detecting a need for retransmission of the received coded data block," "CCU [Channel Coding Unit] [that] is responsible for channel coding, including forward error coding FEC" as well as detecting the "[t]he need for retransmission . . . by an error

detection code or by the fact that an error correcting code cannot correct errors occurring on the channel with sufficient certainty." Ex. 1001, code (57), 2:25, 6:64–65, 7:54–59; *see id.* at Fig. 5, Step 508, 10:41–44. Petitioner has not shown that the '561 patent presents an algorithm for how the error detection code detects an error, nor explained the circumstances under which the error correcting code cannot correct errors and what constitutes "sufficient certainty." *Id.* at 7:54–59. Although the '561 patent discloses examples of incremental redundancy protocols such as "hybrid FEC/ARQ (Forward Error Correction/Automatic Repeat Request), which uses error correction coding in order to decrease the number of retransmissions," it does not present an algorithm for implementing the same. *Id.* at 2:33–37.

For the foregoing reasons and based on the entirety of the record developed during trial, we conclude that Petitioner fails to identify sufficient algorithmic structure corresponding to the "means for detecting" recited in independent claims 5 and 10.

D. Challenges Based on Chen Alone

Petitioner contends that claims 1–3, 5–7, 9, and 10 are unpatentable as anticipated under 35 U.S.C. § 102 by Chen and as obvious under 35 U.S.C. § 103 over Chen. Pet. 38–70. For the reasons that follow, we conclude that Petitioner establishes that claims 1–3 and 9 are unpatentable as obvious under 35 U.S.C. § 103 over Chen. As we determine that Petitioner is successful in its obviousness challenge for these claims, we need not and do not reach Petitioner's anticipation challenge to claims 1–3 and 9 based on Chen.

We further conclude that Petitioner does not establish that any of claims 5–7 and 10 are unpatentable as obvious or as anticipated by Chen.

1. Overview of Chen

Chen is titled "Method and Apparatus for Time Efficient Retransmission Using Symbol Accumulation." Ex. 1003, code (54). Chen discloses convolutional encoder 314 that channel codes input bits using one or more of generators g0, g1, g2, and g3. *See generally id.* at 13–15. According to Chen, "convolutional encoder 314 is designed for the necessary code rate" and produces code symbols with an exemplary code rate of ½ by using "only two generators (e.g., g0 and g1 from summers 514a and 514b, respectively)" and omitting remaining generators g2 and g3. *Id.* at 13:30–33.

A source device sends a packet to a destination device, which "acknowledges every received packet and sends an ACK [acknowledgment] message back to the source device if the packet is received correctly or a NACK [negative acknowledgment] message if the packet is received in error." *Id.* at 12:19–22. "For each transmitted packet, the source device monitors the ACK and NACK messages and retransmits the packets received in error." *Id.* at 12:22–23. In one embodiment, a "retransmitted packet comprises the identical code symbols which were transmitted previously." *Id.* at 13:15–16. In an alternative embodiment, Chen discloses that if the packet from the original transmission, which includes code symbols from generators g0 and g1, is received in error, "the retransmitted packet can comprise the code symbols from other generators which have not been transmitted previously (e.g., generators g2 and/or g3)." *Id.* at 14:4–8.

Chen describes how different code rates can be generated by puncturing. *Id.* at 14:25–26. In Chen's example, the original transmission includes code symbols from generators g0 and g1 for a code rate ½ and the retransmission includes "code symbols from generators g2 and g3 which

have been punctured to rate 3/4." *Id.* at 14:30–33. In this example, "[t]he accumulated packet from both transmissions would comprise code symbols from generators g0, g1, g2 and g3 having a punctured rate [of] 3/10." *Id.* at 14:33–35. Chen discloses that "[p]uncturing reduces the number of code symbols to be retransmitted but also reduces the error correcting capability of the convolutional code." *Id.* at 14:35–37.

According to Chen, "[a]t the receiver, the code symbols for the retransmitted packets can be combined with the corresponding code symbols from prior transmissions or can replace those prior transmitted symbols." *Id.* at 13:33–36.

2. *Obviousness of Independent Claim 1*

a) *Petitioner's Initial Contentions*

"A method of transmitting data in a radio system from a transmitter to a receiver, the method comprising"

Petitioner contends that, "[t]o the extent the preamble is limiting, Chen discloses it."[6] Pet. 38. According to Petitioner, "Chen's exemplary communication system transmits data from a base station 4 to a remote station 6" in which "[t]ransmitter ('TMTR') 126 is located at base station 4, and receiver ('RCVR') 206 is located at remote station 6." *Id.* (citing Ex. 1003, 6:4–29, Fig. 1).

Patent Owner does not specifically address the preamble of independent claim 1. *See generally* PO Resp. Having reviewed the cited evidence and Petitioner's contentions, we are persuaded that Chen teaches the preamble.

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[6] We need not determine whether the preamble is limiting because Petitioner shows sufficiently that it is satisfied by the prior art.

> "*channel coding a data block into a coded data block by using a selected channel coding;*
> *puncturing the coded data block by using a first puncturing pattern;*
> *transmitting the coded data block punctured by the first puncturing pattern to the receiver;*"

According to Petitioner, "Chen teaches channel coding a data block into a coded data block using a convolutional encoder," which is specifically "a 1/4 rate convolutional encoder 314 that outputs a four-symbol coded data block (from generators g0, g1, g2, g3) for each single input symbol." Pet. 39 (citing Ex. 1003, 5:24, 6:31–7:5, 7:16–24, 8:39–9:10, 13:19–27, 13:38–14:8, Fig. 5; Ex. 1002 ¶¶ 347–353, 359); *compare* Pet. 39, *with* Ex. 1001, 7:28–33 (describing convolutional coding as a known method of performing channel coding). Petitioner contends that Chen's

> convolutional encoder 314 generates an encoded data block using all four generators, but only two of the four code symbols (those from g0 and g1) are transmitted (yielding a code rate of 1/2). The other two code symbols (from g2 and g3) are punctured (removed) using a puncturing pattern of "Y Y N N" corresponding to the coded data block sequence of g0 g1 g2 g3. The puncturing pattern is applied after generation of the coded data block because the code symbols from g2 and g3 are available for later retransmission.

Pet. 40–41. Petitioner further contends that a "POSITA would have understood that removing the symbols generated by g2 and g3 (and transmitting only those from g0 and g1), as Chen discloses, constitutes 'puncturing the coded data block by using a first puncturing pattern.'" *Id.* at 41 (citing Ex. 1002 ¶¶ 360–362). Petitioner also contends "Chen teaches that the coded data block punctured by the first puncturing pattern is transmitted to the radio system receiver." *Id.* at 42 (citing Ex. 1003, 3:13–15, 7:6–15, 8:15–23, Fig. 2; Pet. § VIII.A.1.a; Ex. 1002 ¶¶ 363–366).

Chen teaches that, for "an exemplary rate ½ convolutional encoder 314, each input bit results in two output code symbols (e.g., from generators g0 and g1)." Ex. 1003, 14:2–4. Chen explains that, "for a rate ½ convolutional encoder 314, only two generators (e.g., g0 and g1 from summers 514a and 514b, respectively) are necessary and *the remaining generators can be omitted*." *Id.* at 13:30–33 (emphasis added).

In our Institution Decision, we questioned whether "Chen's disclosure of omitting the remaining generators means that generators g2 and g3 do not transmit or . . . [do not] generate any code symbols or data blocks during the original transmission." Inst. Dec. 13. We considered this issue to be of consequence because the '561 patent discloses that channel coding excludes puncturing. *See* Ex. 1001, 7:30–34 ("[C]hannel coding refers to a known method of performing channel coding, for example block coding, convolutional coding or some coding method developed from convolutional coding, excluding, however, puncturing from channel coding."); Ex. 1002 ¶ 348 (citing Ex. 1001, 7:28–33). If a POSITA would have understood from Chen's disclosure that generators g2 and g3 do not generate any code symbols during the initial transition, then the record would not support a finding that any of the code symbols are punctured in the initial transmission.

Based on the entirety of the record developed during trial, we find that the cited portions of Chen would have taught a POSITA to choose different puncturing patterns because Chen explicitly states that "[o]ther code rates can also be generated by using punctured codes and are within the scope of the present invention." Ex. 1003, 14:25–26. This disclosure, in combination with Chen's disclosure that "the original transmission can comprise the code symbols from generators g0 and g1 for rate ½," teaches the claimed "first

puncturing pattern." *Id.* at 14:25–26, 14:30–31. Further, Chen's disclosure of differing code rates and punctured codes and the above-quoted disclosure regarding the original transmission in combination with its disclosure that "the retransmission can comprise code symbols from generators g2 and g3 which have been punctured to rate 3/4" teach the claimed "second puncturing pattern including fewer symbols to be transmitted than the first puncturing pattern," as addressed in further detail below. *Id.* at 14:25–26, 14:30–33.

Having reviewed the cited evidence and Petitioner's arguments, we are persuaded that Chen teaches the channel coding, puncturing, and first transmitting limitations.

> *"detecting a need for retransmission of the received coded data block;*
>
> *transmitting a retransmission request of the coded data block to the transmitter;*
>
> *increasing the code rate of the coded data block to be retransmitted by puncturing the coded data block coded by the channel coding of the original transmission using a second puncturing pattern including fewer symbols to be transmitted than the first puncturing pattern;"*

According to Petitioner, "Chen teaches the use of a cyclic redundancy check ('CRC') polynomial to detect a need for retransmission of a received data block." Pet. 42 (citing Ex. 1003, 3:16–21). Petitioner contends that Chen teaches requesting retransmission by sending a negative acknowledgment (NACK) from a destination device to a source device. *Id.* at 43 (citing Ex. 1003, 3:34–35 ("[I]f the packet was received in error, the destination device transmits a NACK message to the source device."), 12:19–13:11).

With respect to the increasing limitation, Petitioner contends that "Chen first teaches that two of the four total symbols generated (from g2 and g3) are removed, i.e., punctured, to generate an original transmission having a code rate of 1/2." *Id.* at 44 (citing Ex. 1003, 14:2–8; Ex. 1002 ¶¶ 386–387). According to Petitioner, "Chen then teaches two examples that puncture the coded data block with a second, different puncturing pattern to increase the code rate for a retransmission." *Id.* Petitioner contends that, "[i]n each example, Chen . . . teaches that the coded data block for retransmission should be punctured in a different pattern to transmit fewer symbols at an increased code rate." *Id.* at 45 (citing Ex. 1002 ¶ 396).

Chen presents two embodiments—distinguished from examples—a first, exemplary embodiment and second, alternative embodiment. Petitioner relies on only the second, alternative embodiment. We emphasize that the two examples presented in the following paragraphs are both from Chen's *second*, alternative embodiment and *not* its first, exemplary embodiment.

Petitioner asserts that, in Chen's *first* example:

> The code symbols from g0, g1, and g3 are removed, and "[t]he retransmitted packet can comprise the code symbols from generator g2." The punctured coded data block for retransmission has 1 user data symbol to 1 code data symbol for an ***increased*** code rate of 1/1.

Id. at 44–45 (citing Ex. 1003, 14:16–17; Ex. 1002 ¶¶ 390–395) (brackets added by Petitioner).

Petitioner asserts that, in Chen's *second* example:

> Three input symbols generate a 12-symbol coded data block (formed by 3 symbols output from each of g0, g1, g2, g3). For the original transmission, as described above, all of the symbols from g2 and g3 are punctured, yielding a code rate of 1/2. For

> the retransmission, all of the symbols from g0 and g1 are punctured and any 2 of the 6 total symbols from g2 and g3 are punctured, yielding an ***increased*** code rate of 3/4.

Id. at 45 (citing Ex. 1003, 14:30–33, Fig. 5).

Chen teaches the concept of puncturing and punctured codes and different code rates obtainable therefrom. *See id.* at 14:25–30. In the second example Petitioner identifies, Chen discloses that "the original transmission can comprise the code symbols from generators g0 and g1 for rate 1/2 and the retransmission can comprise code symbols from generators g2 and g3 which have been punctured to rate 3/4." *Id.* at 14:30–33.

Petitioner contends, and we are persuaded, that in the Institution Decision, we misapprehended teachings of Chen, in particular, those of the relied-upon, second, alternative embodiment. In the Institution Decision, we found

> Petitioner's showing appears to treat the generators inconsistently between the original transmission and the retransmission. With respect to the original transmission, Petitioner contends that "Chen first teaches that two of the four total symbols generated (from g2 and g3) are removed, i.e., punctured, to generate an original transmission having a code rate of 1/2." Petitioner then contends, with respect to the retransmission, that removing code symbols generated by g0, g1, and g3 and transmitting only code symbols from generator g2, results in a code rate of 1. As such, the omitted generators g2 and g3 "count" towards the code rate of ½ in the original transmission, but omitted generators g0, g1, and g3 do not count towards the code rate of 1 in the retransmission. Were the omitted generators to be treated consistently in the retransmission, we would expect the code rate to drop to ¼.

Inst. Dec. 29 (citing Pet. 44 (citing Ex. 1003, 14:2–8; Ex. 1002 ¶¶ 386–387)).

Petitioner explains, and we are persuaded,

> In that [second] example, Chen teaches transmitting only two of the four generated symbols from g0 and g1. This original transmission therefore has a code rate of 1/2, because each user data bit resulted in the transmission of two coded data bits. Chen then teaches the retransmission of only one of the four generated symbols from g2, which results in an increased code rate of 1/1 or 1 because each user data bit resulted in the transmission of a single coded data bit. Together, both transmissions have a combined code rate of 1/3, because each user data bit has three corresponding coded data bits at the receiver.

Pet. Reply 6–7, n.3 (citing Pet. 44–45, 52; Ex. 1003, 14:2–8, 14:16–17; Ex. 1002 ¶¶ 386–387, 390–395). In particular, we erroneously determined the code rate considering the omitted generators instead of determining the code rate based on the ratio of data to the code symbols that are both generated *and* transmitted, as taught by Chen.

Having reviewed the entirety of the record developed during trial, including Petitioner's contentions, Dr. Kakaes's testimony, and the cited disclosures in Chen, we are persuaded that Chen teaches different puncturing codes that produce differing code rates—code rates that differ between an original transmission and a retransmission—as well as a puncturing code that removes more code symbols for a retransmission than a puncturing code for an original transmission. Accordingly, we are persuaded that Chen teaches the detecting, second transmitting, and increasing limitations.

> *"transmitting the coded data block punctured by the second puncturing pattern to the receiver;*
>
> *combining the received coded data block punctured by the first puncturing pattern and the received coded data block punctured by the second puncturing pattern; and*
>
> *decoding the channel coding of the combined coded data block."*

Petitioner contends that "[t]he retransmitted coded data block is sent from transmitter 126 in base station 4 to receiver 206 in remote station 6

through path 10." Pet. 49 (citing Ex. 1003, 7:11–15, 8:15–17, 15:17–20, 18:23–24, Fig. 2; Ex. 1002 ¶¶ 398–401). Petitioner further contends "Chen describes the process of accumulating the code symbols from the transmitted and retransmitted coded data blocks as 'interleaving,' not the less precise term 'combining.'" *Id.* at 50 (citing Ex. 1003, 14:9–11). Petitioner also contends "Chen teaches that the 'accumulated' coded data block is decoded with a Viterbi decoder at a combined 1/3 code rate." *Id.* at 52 (citing Ex. 1003, 4:4–7, 4:30, 8:24–29, 14:11–24, Fig. 8; Ex. 1002 ¶¶ 415–420).

Having reviewed the entirety of the record developed during trial, including Petitioner's contentions, Dr. Kakaes's testimony, and the cited disclosures in Chen, we are persuaded that Chen teaches the second transmitting, combining, and decoding limitations.

For the foregoing reasons, we are persuaded that Petitioner establishes unpatentability of independent claim 1 over Chen by a preponderance of the evidence.

b) Patent Owner's Arguments

First, Patent Owner argues that, "[c]ontrary to Petitioners' description, Chen discusses varying the number of bits from the convolutional encoder through discrete generators to achieve a different code rate" and, thus, that "Petitioners' argument fails because encoding a data block at a particular code rate does *not* constitute puncturing." PO Resp. 11 (citing Ex. 2005 ¶ 35); *see also id.* at 12 (citing Pet. 44) (Patent Owner disputing that "Chen's disclosure of generating coded data blocks with different code rates by selecting bits from some, but not all, of the encoder generators is the same as 'removing' symbols from a coded data block"). In the same vein, Patent Owner asserts that "Petitioners' expert agrees that puncturing involves *removing* bits from a coded data block, not

just failing to transmit certain bits." *Id.* at 12 (citing Ex. 1002 ¶ 57 ("puncturing is a technique for tailoring the code rate of a transmission by selectively ***removing coded data bits (or symbols) from the coded data block***"); Ex. 2006, 67:6–10 ("What puncturing is is a technique for tailoring the code rate of a particular transmission. In other words, tailoring which bits are transmitted, and you do that by selectively ***removing coded data bits from the set of coded data block***.")); PO Sur-Reply 8–10.

Patent Owner argues that "Chen teaches generating coded data blocks from coded bits coming from some or all of the convolutional encoder's generators" and that "contrary to Petitioners arguments, *Chen does not teach withholding generated code symbols from one or more of the generators during an original transmission* so that they may later be appended during a retransmission; *the generators are entirely omitted from the encoding process until they are called upon* to create code symbols for an encoded data block during the retransmission." *Id.* at 17 (citing Ex. 1003, 13:29–32; Ex. 2005 ¶ 42) (emphases added). According to Patent Owner, "[t]he *symbols* from the remaining generators *are not what is omitted*; the *generators are simply not used* to create the coded data blocks." *Id.* (citing Ex. 2005 ¶¶ 43–44) (emphasis added). Patent Owner also states this same proposition in other words: "[i]t is not that the symbols were not transmitted, but that they were not employed in generating symbols." *Id.* at 18 (citing Ex. 2005 ¶ 44).

In response, Petitioner disputes that Chen "teaches running a convolutional encoder with fewer than all of its generators and then rerunning the convolutional encoder every time a retransmission is needed," instead of "puncturing the original output of the encoder with two (or more) puncturing patterns," as Patent Owner contends. Pet. Reply 14–15 (citing

PO Resp. 17). Petitioner contends that "*[n]o* POSITA at the relevant time could have reasonably interpreted Chen's description of convolutional encoder 314 as 'designed to produce code symbols at various code rates' to mean that Chen instructed running and *re-running* user data through the convolutional encoder to achieve different code rates for retransmissions." *Id.* at 21 (citing Ex. 1023 ¶ 36) (emphasis added).

Petitioner also contends, and we are persuaded, that "a POSITA at the relevant priority date would have understood that Chen's teachings to *selectively transmit* only a subset of the convolutional encoder's output ***is*** puncturing." *Id.* at 15 (emphasis added). More particularly, we are persuaded that "Chen teaches in the 'alternative embodiment' that 'convolutional encoder 314 is designed to produce code symbols at various code rates,' meaning that the output from convolutional encoder 314 *can be modified through puncturing (i.e., reducing redundancy) to achieve different code rates*," as Petitioner contends. *Id.* (citing Ex. 1023 ¶ 31) (emphasis added). Petitioner also persuasively argues that

> [t]he logic function of a convolutional encoder is not simply turned off. Every bit input into a rate 1/4 convolutional encoder like Chen's convolutional encoder 314 necessarily runs through the logic to generate four output bits—one from each of generators g0, g1, g2, and g3. *And a POSITA would know that these outputs are typically stored to at least a temporary memory so they are available as needed for any retransmissions*. This is because a convolutional encoder typically encodes data streams, and it would be both time and resource *inefficient to reseed and rerun the user data through the convolutional encoder* every time a retransmission is needed.

Pet. Reply 20 (citing Ex. 1023 ¶¶ 31–34 (Dr. Kakaes testifying that a POSITA at the relevant date would understand that the output bits from a convolutional encoder can be stored to a memory); Ex. 1024, 114:4–8

(Mr. Bates also testifying that a POSITA would have understood that bits output from a convolutional encoder could be stored in memory)) (emphases added). Dr. Kakaes persuasively explains that

> A POSITA would have further known that, even if the output bits from generators g2 and g3 were not selected for the original transmission, the entire coded data block generated by all generators g0-g3 would have been typically saved to at least a temporary memory where it would be available as needed for any retransmissions. This a matter of common sense as it is the most time and resource efficient use of the output of the convolutional encoder. The alternative would be to run, rerun, and rerun the convolutional encoder again every time a retransmission is requested, which would not only be inefficient but would both add highly undesired delays and also interfere with the transmitter's ability to process the subsequent user data blocks. This inefficiency is compounded further by the necessary delay logic and seeding for each of the shift registers (*i.e.*, each of the eight shift registers in Chen's convolutional encoder 314) before a convolutional encoder is run.

Ex. 1023 ¶ 34. Dr. Kakaes also explains that "Chen never contemplates, and a POSITA would have never considered, instead going back to rerun the convolutional encoder every time a data block was received in error, injecting undesired delay and complexity." *Id.* ¶ 35. Although Patent Owner's Declarant, Mr. Bates, testifies to the contrary—that "Chen's generators do not create symbols that are subsequently withheld from the encoded data block or transmission depending on the desired code rate," but instead "the generators are entirely omitted from the process of encoding the data block"—Petitioner points out, and we are persuaded, that Mr. Bates is addressing Chen's exemplary embodiment "which only retransmits the original transmission, so there is never a need to save and retransmit different coded symbols from the originally generated coded block." Pet.

Reply 20, n.7 (citing Ex. 2005 ¶ 42; PO Resp. 17; Ex. 1003, 13:29–32).[7] As noted above, however, Chen also discloses a second, alternative embodiment upon which Petitioner solely relies.

Petitioner takes the position that "the output can be punctured to transmit coded symbols generated by particular generators" and "[o]r, alternatively, a different pattern can be punctured from the output of all four generators or a subset of generators that were already punctured." *Id.* (citing Ex. 1023 ¶¶ 37–38). Petitioner more particularly explains that

> Chen specifically teaches puncturing the code symbols from generators g2 and g3 so that only the symbols from generators g0 and g1 are transmitted. This is a "YYNN" or "1100" puncturing pattern. The code rate for this original transmission is the ratio of one user data bit to two coded data bits or 1/2. Chen then teaches sending new code symbols in the retransmitted packet, specifically, in one example, the punctured code symbols from only generator g2 with an increased code rate of 1/1 because the ratio for the retransmission is one user data bit to one coded data bit. The receiver, accumulating the 1/2 code rate original transmission from g0 and g1 with the 1/1 code rate retransmission from g2, now has a coded data block with a code rate ratio of one user data bit to three coded data bits or 1/3. Chen then uses a 1/3 code rate Viterbi decoder to decode the combined 1/3 code rate coded data block.

Id. (citing Ex. 1003, 14:4–8, 14:13–18; Ex. 1002 ¶¶ 54–55, 238; Ex. 1023 ¶ 35; Ex. 1002 ¶ 278).

Dr. Kakaes explains, and we agree, that "Chen's selective transmission (*i.e.*, puncturing) of the output from only certain generators is also consistent with the only embodiment from the '561 patent, which relies on this same type of puncturing pattern." Ex. 1023 ¶ 39. Dr. Kakaes further

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[7] Mr. Bates cites column 30, lines 30–32 of Chen in support of his testimony. We presume this citation to be a typographical error.

explains the chart, reproduced below, comparing Chen's *second*, alternative embodiment with the embodiment shown in Figure 4 of the '561 patent in support of Petitioner's contentions.

	Chen Ex. 1003, 14:4-6, 13-18[8]	**'561 patent: Figure 4** Ex. 1001, 7:34-52
Convolutional encoder	1/4 code rate	1/3 code rate
First puncturing pattern	YYNN (g0, g1)	NYY (g1, g2)
Second puncturing pattern	NNYN (g2)	YNN (g0)
Combined coded data block	YYYN (g0, g1, g2)	YYY (g0, g1, g2)
Combined code rate	1/3	1/3

Chart comparing Chen's second, alternative embodiment with the Figure 4 embodiment of the '561 patent.
Ex. 1023 ¶ 40; Pet. Reply 22.

According to Dr. Kakaes, "the only difference between Chen's disclosures and the '561 patent's Figure 4 embodiment is that Chen starts from a 1/4 convolutional encoder, whereas the '561 patent starts from a 1/3 convolutional encoder." Ex. 1023 ¶ 40. Dr. Kakaes points out, however, that "the claims of the '561 patent are not limited to a 1/3 convolutional encoder, or any encoder for that matter, because they only broadly claim 'channel coding a data block into a coded data block by using a first puncturing pattern.'" *Id.* ¶ 41 (citing Ex. 1001, claim 1).

Petitioner contends, and we agree, that

> [t]he lone '561 embodiment in Figure 4 relies on the output from a 1/3 code rate convolutional encoder. The '561 patent describes a first puncturing pattern in which "the first symbol and every third symbol thereafter" are removed, which it described as a "011011011" puncturing pattern. The output of a 1/3 code rate

> convolutional encoder can be organized by its three generators, g0, g1, and g2. Described from the perspective of the generators, the '561 patent's "first puncturing pattern" simply consists of the output from generators g1 and g2, which have a code rate of 1/2, and omits the output from generator g0.

Pet. Reply 21–22 (citing Ex. 1023 ¶ 39; Ex. 1001, 7:21–25, 7:34–44, Fig. 4).

Second, Patent Owner contends that Petitioner refers to an "excerpt of Chen that purportedly discusses puncturing, but even [this excerpt of] Chen does not disclose the invention recited in the claims of the '561 patent" and instead, "Chen discusses only a single instance of data puncturing in [the cited] section." PO Resp. 13 (citing Ex. 2005 ¶ 36; Ex. 1003, 14:30–37; Pet. 45). According to Patent Owner, it is notable that Chen presents the corresponding disclosure from

> th[e] section immediately *following* the section Petitioners assert discloses puncturing. Chen says, "[o]ther code rates can also be generated by using punctured codes and are within the scope of the present invention." In other words, Chen distinguishes between the previous section that Petitioners claim discloses puncturing and this section where, for the first time, Chen introduces the idea that puncturing can also be used to control code rates.

Id. (citing Ex. 1003, 14:25–26). Patent Owner also contends that "the wholesale abandonment of Chen's exemplary embodiment directly undermines Petitioners own invalidity analysis, as it relies on multiple embodiments to demonstrate invalidity." PO Sur-Reply 6 (citing Pet. 43, 56, 60); *see id.* at 3–6.

In response, Petitioner takes the position that Patent Owner's arguments confuse two embodiments in Chen—the first, exemplary embodiment and the second, alternative embodiment discussed above—and that Petitioner only relies on the second, alternative embodiment. Pet. Reply

7–8. Petitioner clarifies that the second, alternative embodiment on which Petitioner relies "does not use 'identical code symbols'" but "instead applies a second puncturing pattern to transmit *a different set of symbols*." Pet. Reply 11, n.5 (citing Ex. 1023 ¶¶ 12–16) (emphasis added). Petitioner also relies on two different examples in Chen's second, alternative embodiment, as set forth above in the analysis of Petitioner's element-by-element showing. Patent Owner's argument is unavailing—we can consider and rely on separate disclosures in Chen to support a finding as to the above-quoted claim limitations, in particular because the disclosures in Chen cited by Petitioner are with respect to the same, second, alternative embodiment upon which Petitioner solely relies. We do not determine that the sections of Chen pointed to by Patent Owner are incompatible, or mutually exclusive, nor do we determine that Petitioner improperly relies on multiple embodiments without adequate rationale for combining the embodiments. We also note that Patent Owner apparently concurs with Petitioner's position in its statement that "Chen describes encoding the data block a second time at the same code rate as the original transmission, but then puncturing the newly generated coded data block *to achieve a different code rate prior to retransmission*." PO Resp. 13 (citing Ex. 1003, 14:25–33; Ex. 2005 ¶ 36) (emphasis added)).

Third, Patent Owner argues that "Chen's disclosure of encoding data blocks at different rates does not disclose or render obvious the '561 patent" and instead, "teaches away from using multiple puncturing schemes." *Id.* at 17. As set forth above, Patent Owner argues that "Chen does not teach withholding generated code symbols from one or more of the generators during an original transmission" and instead, "the generators are entirely omitted from the encoding process until they are called upon to create code

symbols for an encoded data block during the retransmission." *Id.* (Ex. 1003, 13:29–32; Ex. 2005 ¶ 42). Patent Owner further argues that "Chen discusses this in detail when describing how a "convolutional encoder 314 is designed for the necessary code rate." *Id.* (citing Ex. 1003, 13:29–30).

A reference teaches away "when a person of ordinary skill, upon reading the reference, would be discouraged from following the path set out in the reference, or would be led in a direction divergent from the path that was taken" in the claim. *Galderma Labs., L.P. v. Tolmar, Inc.*, 737 F.3d 731, 738 (Fed. Cir. 2013). A reference that "merely expresses a general preference for an alternative invention but does not criticize, discredit, or otherwise discourage investigation into" the claimed invention does not teach away. *Id.*

In the present proceeding, we determine that neither the cited portions of Chen set forth above, nor any other portion of Chen, discourages, criticizes, or discredits multiple puncturing schemes. Even assuming, *arguendo*, Patent Owner's contention that Chen does not teach "withholding generated code symbols from one or more of the generators" and instead teaches "entirely omit[ing] those generators from the encoding process until . . . called upon," we find Patent Owner's contention unavailing for the same reason. We determine that Chen's disclosure that "[p]uncturing reduces the number of code symbols to be retransmitted but also reduces the error correcting capability of the convolutional code" is a tradeoff that a POSITA would consider, not a disparagement. Ex. 1003, 14:35–37. In fact, Chen expressly discloses that different "code rates can also be generated by using punctured codes and are within the scope of the present invention." *Id.* at 14:25–26.

Fourth, Patent Owner argues that "Chen's clear direction that packets are 'not combined' shows that Chen prohibits combining the two coded data blocks, and instead embraces the separate concept of interleaving" and further, that "Petitioners' expert ignored Chen's distinction between combining and interleaving during his deposition and simply repeated what Chen had already rejected, that 'interleaving is one way of performing combining." PO Resp. 14 (citing Ex. 2006, 83:4–9, 85:13–16); PO Sur-Reply 6–7.

In his Declaration, Mr. Bates testifies that "Chen draws a clear distinction between interleaving and combining where he states that 'retransmitted packets are interleaved (not combined)'" and that "Chen does not combine the originally transmitted data block and its retransmitted counterpart, but merely interleaves them." Ex. 2005 ¶ 38 (citing Ex. 1003, 14:9–10). Mr. Bates also "note[s] that Dr. Kakaes claims that interleaving is a subset of combining" and testifies that "such an understanding is belied by Chen's rejecting combining—Chen does not explicitly reject combining to then recommend a form of combining." *Id.* (citing Ex. 1002 ¶ 413). During his deposition, Mr. Bates testifies as follows:

> Q. What would a person of ordinary skill in the art have understood the term "interleaving" to mean at the relevant priority date of September 1999?
>
> A. And you said the term "incrementing?"
>
> Q. Yes. Interleaving.
>
> A. Oh, Interleaving. I'm sorry. Combining says I'm putting two pieces back together. Interleaving is a different process. When I'm going to interleave, I'll read my data in in a serial data stream, and I'll read it into a buffer or a memory, and I'll interleave it in in rows. When I'm then going to send it out, I will read it out in columns. So let's say I had a four-by-four square

> here or four little squares. So the four-by-four, I would read the data in horizontally, and I would transmit it out vertically. By doing interleaving, what I'm doing is I'm spreading the data across a bigger spectrum, if you will. If I start to have errors, normally have bursts of errors. So by having a burst of errors I could have four bits in a row being errored, corrupted. But because we interleave, what happens is the interleave, because
>
> I've read them in horizontally, out vertically, and then when I bring them back in, I read them in horizontally, what it does is it spreads out the errors so there's an easier fix or its easier to detect the errors. And if we're looking at just single bit errors instead of bursts of errors now, I can usually do some form of error correction. They're two different processes.

Ex. 2008 at 48:1–49:7.[8]

Petitioner responds that Chen discloses "a second 'alternative embodiment' in which ***different*** code symbols are received and accumulated together through a process Chen calls 'interleaving' to achieve a combined 'lower code rate' (*i.e.*, adding together the additional redundancy from the two transmissions)." Pet. Reply 12 (citing Ex. 1003, 13:38–14:24). Petitioner contends that "Patent Owner asks the Board to myopically focus on the fact that Chen calls this process of accumulating different code symbols 'interleaving,' instead of 'combining,' which is the word used in the '561 patent for this concept." *Id.* (citing PO Resp. 14–15). Petitioner further contends, and we agree, that "'combining' in the '561 patent and 'interleaving' in the second embodiment of Chen are the exact same thing" because "[b]oth involve the ***same concept***: collecting together different coded symbols from the transmission and retransmission to be decoded

[8] Patent Owner only files "excerpts" of Mr. Bates's testimony. *See* Ex. 2008. As such, the identity of the person deposing Mr. Bates is unknown. For this reason, in this excerpt of testimony, we do not attribute the questions to anyone but attribute the answers to Mr. Bates.

together at a lower code rate." *Id.* (citing Ex. 1001, 8:21–32; Ex. 1002 ¶¶ 269–271, 402–414).

In our Institution Decision, we found persuasive Dr. Kakaes's testimony that "Chen's 'interleaving' of the original transmission and the re-transmission is precisely the same type of 'combining' described in the '561 patent" and that "a POSITA would understand that 'interleaving' is a more specific description of the method the '561 patent described in Figure 4," which the '561 patent refers to as combining. Inst. Dec. 31–32 (citing Ex. 1002 ¶ 413; Ex. 1001, 8:26–32). In the Institution Decision, we found that the cited portion of the '561 patent supports Dr. Kakaes's testimony because we determined that the cited portion discloses interleaving:

> In the example of FIG. 4, the second, third, fifth, sixth, eighth and ninth symbol of a combined coded data block 412 are obtained from the coded data block 408 punctured by the first puncturing pattern 404, and the first, fourth and seventh symbol are obtained from the coded data block 410 punctured by the Second puncturing pattern 406.

Id. at 32 (citing Ex. 1001, 8:26–32).

Even having considered Patent Owner's arguments in its Response and Sur-Reply and having considered Mr. Bates's Declaration and deposition testimony and the entire record developed during trial, we find Patent Owner's arguments unavailing. Instead, having considered the entirety of the record, we are persuaded, as we initially set forth in our Institution Decision, that the

> record does not support the finding that "combining" as recited in claim 1 excludes interleaving as taught by Chen. Further, although Chen distinguishes interleaving from combining in one instance, it also discloses accumulating packets and combining packets. For example, Chen discloses that a "destination device receives the retransmitted packet, accumulates energy of the

> retransmitted packet with the energy already accumulated for the packet received in error, and decodes the accumulated packet" and that the "[t]he accumulation can be accomplished with an arithmetic logic unit (ALU)."

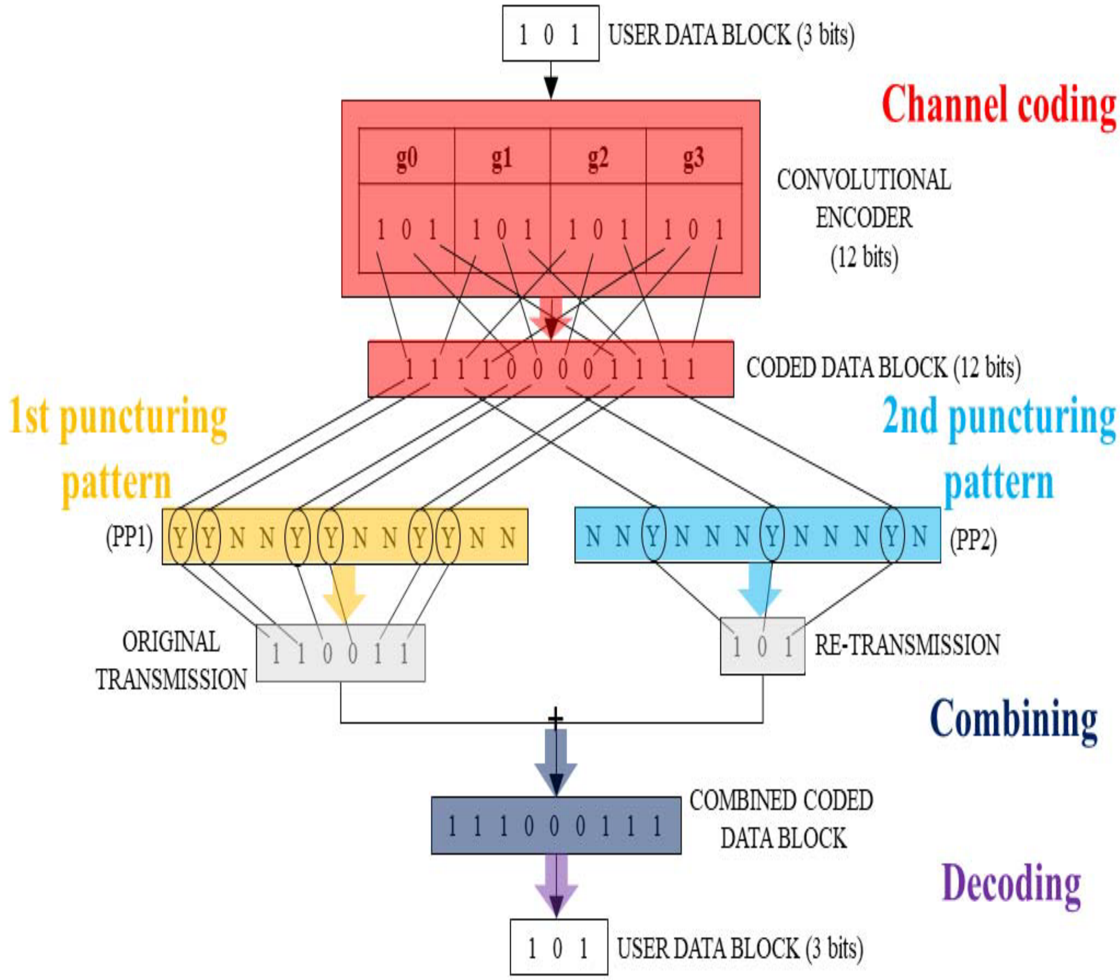
Inst. Dec. 32 (citing Ex. 1003, 13:33–36, 14:9–13, 14:17–24, 14:33–35, 18:24–27, 18:36–37).

3. Obviousness Dependent Claims 2 and 3

Patent Owner does not separately argue the dependent claims, in particular, claims 2 and 3. *See e.g.*, PO Resp. 9–18.

Claim 2 recites "wherein the symbols to be transmitted of the first puncturing pattern and the second puncturing pattern together comprising as many of the symbols of the coded data block as possible."

Petitioner contends that "Chen teaches the use of puncturing patterns that are 'completely separate' with no overlap of symbols in the transmitted coded data." Pet. 67 (citing Pet. § VIII.A.1.g). Petitioner presents a diagram, reproduced below, which Petitioner asserts corresponds to Chen's embodiment disclosed in column 13, line 38 through column 14, line 18. *Id.* at 68.



Petitioner's diagram illustrating the method of Chen's second, alternative embodiment. Pet. 68 (citing Ex. 1003, 13:38–14:18).

According to Petitioner, "[t]he coded symbols transmitted after the first puncturing pattern (*i.e.*, the symbols generated by g0 and g1) are 'completely separate' from the coded symbols retransmitted after the second puncturing pattern (*i.e.*, the symbols generated by g2)" and as such, "there is no overlap in the transmitted and retransmitted symbols," and accordingly, "the transmissions 'compris[e] as many of the symbols of the coded data block as possible.'" *Id.* Petitioner compares Chen's disclosure to that of the '561 patent:

> The ’561 patent specification states it is “preferable” in the Figure 4 example “that the symbols to be transmitted of the first puncturing pattern 404 and the second puncturing pattern 406 together comprise as many of the symbols of the coded data block 402 as possible,” which can be accomplished through puncturing patterns for the transmission and retransmission that are “completely separate,” *i.e.*, with no overlap in the coded data blocks.

Id. at 67 (citing Ex. 1001, 8:32–41).

Petitioner contends that to the extent claim 2 “require[s] that ***all*** coded bits in the coded data block are sent in the two transmissions, it would have been obvious to a POSITA to use Chen’s teachings to do so.” *Id.* at 68 (citing Ex. 1002 ¶¶ 556–562). More particularly, Petitioner contends that

> To maximize the error-correction capability of the convolutional coder, especially after a need for retransmission is detected and if channel conditions are unfavorable, a POSITA would appreciate the advantages of sending the maximum number of code symbols in the transmission and retransmission, including all symbols, and would be motivated to use the teachings of Chen to transmit as many symbols as possible between the two transmissions. This is reinforced by Chen’s second example in which coded symbols from g0, g1, g2, and g3 are sent in the transmission and retransmission, and Chen’s teaching that “[o]ther code rates can also be generated.”

Id. at 69 (citing Ex. 1002 ¶¶ 556–562, 625–626; Ex. 1003, 14:25–37); *see id.* (citing Ex. 1002 ¶ 83; Ex. 1001, 7:36–39, Ex. 1003, 14:33–37).

We are persuaded that the cited portions of Chen and Dr. Kakaes’s testimony support Petitioner’s contentions. Accordingly, Petitioner establishes unpatentability of claim 2 by a preponderance of the evidence.

Claim 3 recites “wherein the code rate of the punctured coded data block does not exceed 1.” Petitioner contends that “Chen ***only*** teaches the transmission (and retransmission, for that matter) of coded data blocks at a

code rate of 1 or less." *Id.* at 70 (citing Ex. 1003, 13:28–14:37 (code rates of 1/2, 3/4, and 1); 14:17–18 (combined code rates of 1/3, 1/4, and 3/10); Ex. 1002 ¶¶ 503–505). We are persuaded that the cited portions of Chen and Dr. Kakaes's testimony support Petitioner's contentions. Accordingly, Petitioner establishes unpatentability of claim 3 by a preponderance of the evidence

4. Obviousness of Independent Claim 9

Petitioner's element by element analysis for independent claim 9 relies on portions of Chen substantially overlapping with those portions cited with respect to independent claim 1. *See* Pet. 59–62. We have reviewed Petitioner's contentions, Dr. Kakaes's testimony, the cited evidence, and in particular, the portions of Chen cited to teach the function and corresponding structure of the alleged means-plus-function terms in these claims, for which we determined sufficient structure had been identified in the Petition. *Id.* (citing Ex. 1003, 3:33–35, 6:4–7:15, 9:11–25, 10:9–21, 12:19–13:11, Fig. 2; Ex. 1002 ¶¶ 462–472; Pet. §§ VIII.A.1, VIIII.A.2).

We are satisfied that Petitioner sufficiently identifies, in the prior art, the limitations recited in independent claim 9, and in particular, elements in Chen encompassed by the means-plus-function constructions set forth in Section III.C. Accordingly, we are persuaded that Petitioner establishes obviousness of claim 9 over Chen by a preponderance of the evidence for reasons substantially similar to those set forth above with respect to claim 1.

5. Anticipation and Obviousness of Independent Claims 5 and 10 and Dependent Claims 6 and 7

As discussed above, we determine that the "means for detecting" limitation recited in independent claims 5 and 10 lacks identified structure corresponding to the "detecting" function. *Supra* § III.C. As we are unable

to conclude what structure is encompassed by the "means for detecting," we cannot reach a conclusion as to whether Chen teaches or suggests the subject matter of claims 5 or 10. More particularly, we cannot conclude whether Chen teaches or suggests the "means for detecting" recited in claims 5 and 10 because the record does not show that corresponding structure has been identified and/or exists in Chen. Having considered the entirety of the record developed during trial, and for the reasons discussed in above in Section III.C, we determine that Petitioner does not establish independent claims 5 and 10 are unpatentable, either as anticipated by or obvious over Chen, by a preponderance of the evidence.

As claims 6 and 7 depend from independent claim 5, we further determine, based on the entire record developed during trial, that Petitioner does not establish that these claims are unpatentable, either as anticipated by or obvious over Chen, by a preponderance of the evidence.

E. Challenges Based on Chen and Eriksson and Chen and GSM 03.64

Petitioner contends that claims 1–10 are unpatentable under 35 U.S.C. § 103 as obvious over Chen and Eriksson and as obvious over Chen and GSM 03.64. Pet. 70–90. For the reasons that follow, we determine that Petitioner does not establish unpatentability of claims 1–10 over Chen and Eriksson by a preponderance of the evidence. We further determine that Petitioner does not establish unpatentability of claims 1–10 over Chen and GSM 03.64 by a preponderance evidence. As Petitioner argues these challenges together, we also address Petitioner's third and fourth challenges together.

1. Overview of Eriksson

Eriksson is titled "Comparison of Link Quality Control Strategies for Packet Data Services in EDGE" and evaluates link adaptation and incremental redundancy, which are link quality control methods. Ex. 1004, 1.[9, 10] Eriksson also proposes its own link quality control method, "two burst based link quality control (2BB LQC)," which is described in the following paragraphs. *Id.* at 2. Eriksson describes modulation and coding schemes (MCSs) in EGPRS, in which "MCS changes are enabled on retransmission by partitioning the MCSs into families (cf. Table 1)." *Id.* at 3.[11] Table 1, reproduced below, includes family designations and code rates for MCSs.

MCS	Modu-lation	Max. rate [kbps]	R_1	R_{1+2}	R_{1+2+3}	Sub-blocks per radio block	Family
8	8PSK	59.2	1	0.5	0.33	2	A
7		44.8	0.76	0.38	0.25*	2	B
6		29.6	0.49	0.24*	-	1	A
5		22.4	0.37	0.19*	-	1	B
4	GMSK	17.6	1	0.5	0.33	1	C
3		14.8	0.85	0.42	0.28*	1	A
2		11.2	0.66	0.33	-	1	B
1		8.8	0.53	0.26*	-	1	C

Table 1: Parameters for MCS-1 to MCS-8 of the 2BB scheme (* code rates less than 1/3 are obtained by repetition).

Table 1 of Eriksson indicates code rates, subblock(s) per radio block, and family designations for various MCSs. Ex. 1004, 2.

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9 Eriksson has two sets of page numbers. This Decision references the page numbers added by Petitioner.

10 The acronym "EDGE" is not defined in Eriksson. We understand EDGE to refer to Enhanced Data rates for GSM, consistent with Dr. Kakaes's identification of acronyms in his First Declaration. *See* Ex. 1002, iiii.

11 The acronym EGPRS is not defined in Eriksson. We understand EGPRS to refer to Enhanced General Packet Radio Service, consistent with Dr. Kakaes's identification of acronyms in his Declaration. Ex. 1002, iii.

Eriksson discloses that "data block sizes for one family are multiples of each other." *Id.* at 3. Eriksson discloses family A as including MCS-3, MCS-6, and MCS-8 in which MCS-8 and MCS-6 have the same block size. *Id.* "In MCS-8, two subblocks, each obtained by encoding and puncturing a data block to rate one fit into one *radio block*." *Id.* In MCS-6, "only one subblock, obtained by encoding and puncturing the same data block to rate 0.49, fits." *Id.* Eriksson also discloses that "it is possible to increase the code rate granularity by decreasing the subblock size of retransmissions," for example, by "making the retransmitted subblocks half as large as the first," which results in "code rates R_1, $2R_1/3$, $2R_1/4$, $2R_1/5$ etc." *Id.* In the case where the third member of family A, MCS-3, is used to retransmit "a data block initially sent with MCS-6 or MCS-8, the data block is resegmented into two." *Id.* Eriksson further discloses that "[e]ncoding and puncturing each part to rate 0.85 give[s] two subblocks fitting the MCS-3 subblock size." *Id.*

According to Eriksson, "[t]he ability to change [MCSs] on retransmission is most important if IR [incremental redundancy] is not used." *Id.*

2. Overview of GSM 03.64

GSM is a standard for cellular telecommunications radio systems. This particular version of GSM, GSM 03.64, discloses the structure of radio blocks to be transmitted, modulation and channel-coding schemes including convolutional coding, and puncturing to modify code rates. Ex. 1005, 20–30. In particular, GSM 03.64 specifies coding parameters for modulation and coding schemes MCS-1 through MCS-9. *Id.* at 30 (Table 4). GSM 03.64 also depicts encoding and puncturing for each MCS. *Id.* at 25–29 (Figures 10–18). Reproduced below, Figure 10 of GSM 03.64 depicts

channel-coding user data with rate 1/3 convolutional encoding and puncturing for MCS-9.

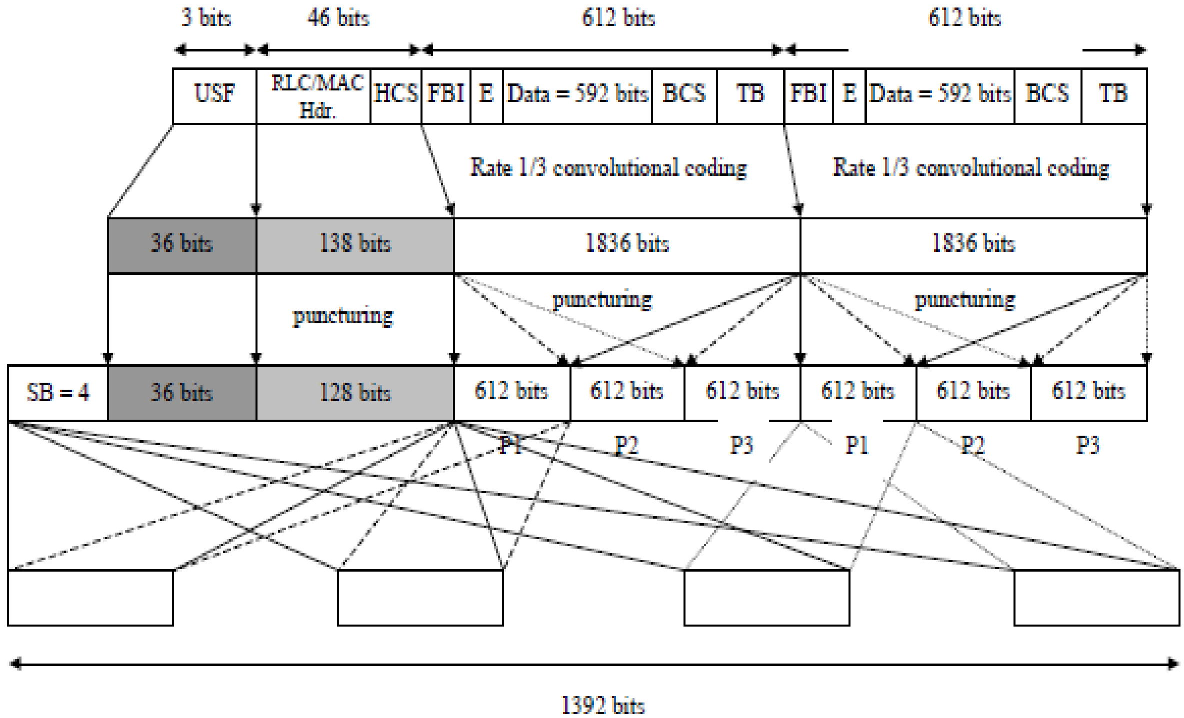

Figure 10 of GSM 03.64 depicts convolutional coding and puncturing for MCS-9.

Id. at 25. GSM 03.64 also discloses that "[t]he P_i for each MCS correspond[s] to different puncturing schemes achieving the same coding rate." *Id.* at 30.

3. *Claims 1–10 and Petitioner's Rationale for Combining Chen with Eriksson and Chen with GSM 03.64*

a) *Petitioner's Initial Contentions*

With respect to its third and fourth challenges, Petitioner contends that "[t]o the extent Chen is found to lack any limitation, it can be combined with either Eriksson or GSM 03.64, which could supply all limitations except for potentially some of the means-plus-function elements, to invalidate the '561 claims." Pet. 71. Petitioner addresses the "Chen/Eriksson and Chen/GSM

03.64 grounds . . . together.” *Id.* In the Institution Decision, we determined Petitioner’s rationale for combining Eriksson and Chen as well as Petitioner’s rationale for combining Eriksson and GSM 03.64 were insufficient. Inst. Dec. 41–44.

Petitioner presents the following reasons to combine Chen with Eriksson and GSM 03.64.

> *First*, Chen, Eriksson, and GSM 03.64 are all in the same art, which is the transmission and retransmission of data in cellular radio systems.
>
> *Second*, Chen, Eriksson, and GSM 03.64 all teach the same aspect of data retransmission—incremental redundancy techniques.
>
> *Third*, Chen, Eriksson, and GSM 03.64 all addressed the same problems. Chen was directed to maintaining throughput, maximizing capacity, and improving decoding performance. Eriksson was similarly focused on optimizing performance and throughput while reducing delay. The GSM standard is similarly directed to protocols for an efficient and interoperable system with optimized throughput, capacity, and performance.
>
> *Fourth*, GSM was the predominant cellular standard by the alleged date of invention. It served more than 65 million customers in 100 countries at the time. GSM did not just suggest EGPRS protocols, moreover, it mandated MCS functionality and incremental redundancy for EGPRS-compliant mobile stations. A POSITA would have had knowledge of the relevant industry requirements and looked to implement useful teachings under this prevailing standard. Chen’s disclosure of methods for improving the efficiency of incremental redundancy techniques to improve throughput rate would have appealed to a POSITA who would understand the relevance of Chen’s teachings to incremental redundancy in the newly-added EGPRS schemes.
>
> *Fifth*, reinforcing the fourth point above, Chen cross-references a 2G standard known as “IS-95A.” In other words, Chen illustrates that it was common to look to standards as part of any discussion about cellular systems.

> *Sixth*, Chen, Chen's employer (Qualcomm), Eriksson, and Eriksson's employer (Ericsson), were active in the field of telecommunications, worked in cellular radio system design for decades, held dozens of patents in this space, and participated in standard-setting organizations. These sources would have been natural for a POSITA to combine.
>
> Applying Eriksson and GSM 03.64's teachings to Chen would have been applying known techniques to improve the similar incremental redundancy techniques already taught by Chen in the same manner.

Pet. 71–73 (citing Ex. 1002 ¶¶ 333–340; Ex. 1003, 1:31–35, 2:43–46, 4:12–5:8, 15:55–64; Ex. 1004, 2; Ex. 1005, 1, 21) (emphases and formatting added).

Seventh, Petitioner contends that "[a] POSITA would be motivated to increase the code rate in view of Eriksson's teachings about the benefits of increased code rate granularity and adaptation to channel conditions." *Id.* at 79 (citing Ex. 1004, 1–2, 5).

Eighth, Petitioner argues that:

> A POSITA, applying Eriksson or GSM 03.64 to Chen, would have understood the benefits of selecting a second MCS with increased puncturing for an increased code rate for the retransmission (*i.e.*, any of the last three options), if needed, particularly when channel conditions are favorable and few additional coded bits are likely needed to correct errors. An increased code rate would also increase the granularity of the decreased combined code rate.

Id. at 80–81 (citing Ex. 1002 ¶¶ 535–538, 613; Ex. 1004, 3).

Ninth, Petitioner contends that it would have been obvious "to a POSITA to use a second, different puncturing pattern for the retransmitted coded data block based on Chen and Eriksson's disclosures for retransmitting the coded data block at a higher code rate and a POSITA's

knowledge of incremental redundancy (including type-II HARQ) and link adaption in the prior art." *Id.* at 81 (citing Ex. 1002 ¶¶ 531–540, 606–614).

Petitioner cites the Petition at pages 87–88 and 89–90 as the basis for its *tenth* reason for combining Chen with Eriksson and GSM 03.64. We note that Petitioner's tenth reason is presented only with respect to its challenge to dependent claims 4 and 8. Pet. 85. Claim 4 recites

> *wherein a combination of modulation and coding schemes used in an EGPRS in an original transmission and in a retransmission being one of the following:*
> *modulation and coding scheme six and modulation and coding scheme nine,*
> *modulation and coding scheme five and modulation and coding scheme seven, and*
> *modulation and coding scheme six using padding bits and modulation and coding scheme eight.*

Claim 8 recites substantially similar features. Petitioner argued reasons 4 and 10 together, presumably with respect to independent claim 1, during oral argument and asserted that the reasons "should be considered as a whole and not . . . in isolation." Tr. 28:1–4. We address Petitioner's tenth reason along with reasons 1 through 9 in the context of our analysis of the independent claims, particularly because it is not clear that Petitioner's Reply arguments addressing the applicability of Chen to GSM are limited to dependent claims 4 and 8 only. We note, however, that our conclusions with respect to the entirety of Petitioner's third and fourth challenges would be the same regardless of how we consider Petitioner's tenth reason.

As context for Petitioner's tenth reason, we note that Petitioner asserts that "Eriksson teaches the use of a modified type-II HARQ for link adaptation and incremental redundancy" through "MCS families punctured to different, compatible code rates." Pet. 78–79 (citing Ex. 1004, 1–3,

Table 1, Fig. 1). According to Petitioner, "[t]he MCSs in each 'family' have different code rates (in column R1), so switching between MCSs for a retransmission necessarily changes the code rate" which "will necessarily either be higher or lower than the original transmission." *Id.* at 79 (Ex. 1004, 2; Ex. 1002 ¶¶ 532–540). Petitioner makes similar assertions with respect to GSM 03.64 and asserts that,

> [u]nder the teachings of GSM 03.64, if a transmission was sent with an "A" family MCS, the retransmission may use another MCS from the "A" family, which punctures the coded data block to a different code rate. If, for example, a "family A" MCS-6 transmission is sent at a 0.49 code rate, the retransmission—which must be chosen from one of the family A schemes—can be any of MCS-6 (same code rate), MCS-8 (increased 0.92 code rate), MCS-9 (increased 1.0 code rate), or MCS-3 (increased 0.80 code rate).

Id. at 80 (citing Ex. 1005, 43; 1002 ¶¶ 611–613). With that context, we set forth Petitioner's tenth contention in the following paragraph.

Tenth, Petitioner contends that

> Eriksson teaches two of the three claimed MCS combinations in claims 4 and 8 of the '561 patent, which are the ***only*** available 8PSK family combinations in Eriksson. Again, these MCS combinations were selected from a finite number of identified, predictable combinations taught by Eriksson and with a reasonable expectation of success . . . .

Id. at 89–90 (citing Ex. 1002 ¶¶ 571–574); *see id.* at 87–88 (citing Ex. 1002 ¶¶ 632–640).

b) Patent Owner's Arguments

Patent Owner does not present any particular arguments in its Response, but represents that it "stands by the arguments contained in Patent Owner's Preliminary Response pertaining to the combinations of references as not rendering any claim of the '561 patent obvious." PO Resp. 19. Patent

Owner improperly attempts to incorporate by reference the arguments from its Preliminary Response. *See* Paper 12, 8 ("[A]ny arguments not raised in the response may be deemed waived."). Nonetheless, we determine that Petitioner's motivation for combining Chen with either Eriksson or GSM 03.64 is not supported by sufficient rational underpinning, for the reasons discussed below.

c) Petitioner's Reply Arguments

In its Reply, Petitioner contends that "Chen expressly describes the benefits of his teachings for a retransmitted data packet that 'comprises new code symbols which may not have been transmitted previously'" and reproduces Chen's disclosure describing its benefits—"provid[ing] enhanced error correcting capabilities," "saving . . . code symbols [that] can then be used for the retransmitted packet," and possibly "operat[ing] symbol repetition in the nominal matter." Pet. Reply 23 (citing Ex. 1003, 13:38–14:2, 14:23–24, 14:38–15:3, 15:9–22) (emphasis omitted). Petitioner further contends that

> [a] POSITA would have reviewed Chen and been motivated to use Chen's "alternative embodiment" to improve the efficiency of a radio system. That POSITA would have recognized that Chen's teachings to send retransmissions at a higher code rate achieved through a second puncturing pattern different from the original transmission would allow a radio system to better adapt to the channel conditions and reduce the necessary redundancy for retransmissions. *That POSITA would have been motivated in particular to apply Chen's teachings to the incremental redundancy scheme recently specified in the then prevalent [sic] and growing-in-popularity GSM standard by the relevant priority date.*

Id. at 24 (citing Ex. 1002 ¶¶ 46–47) (emphasis added).

Petitioner focuses its Reply arguments on the fact that "GSM had more than 100 million global subscribers by 1999 and was in a period of transition, with new technical standards for GPRS and EGPRS adding new Gaussian Minimum-Shift Keying (GMSK) and 8PSK modulation and channel-coding schemes." *Id.* at 24 (citing Ex. 1001, 1:31; Ex. 1002 ¶¶ 21–22, 35–37, 43–44, 46). Petitioner contends that a "POSITA wanting to recognize the efficiencies of Chen's adaptable data retransmission scheme would appreciate that Chen's teachings for a rate 1/4 convolutional encoder like 314 could be easily implemented in radio systems compliant with GSM's GPRS and EGPRS specifications." *Id.* at 24–25 (citing Ex. 1023 ¶ 48). According to Petitioner, Chen expressly disclosed the relevance of its teachings not just to code division multiple access (CDMA) modulation techniques, but also to "[o]ther multiple access communication system techniques," like GSM's TDMA. *Id.* at 25 (citing Ex. 1003, 1:15–20; Ex. 1002 ¶ 237). Petitioner also contends that "[a] POSITA would have further recognized that GSM's new spread spectrum MCSs were a uniquely good fit for Chen's teachings in view of Chen's support for CDMA's spread spectrum modulation techniques." *Id.* (citing Ex. 1003, 1:20–22; Ex. 1023 ¶ 47). According to Petitioner, "[a] POSITA wanting to apply Chen's teachings to current standards would have further looked to GSM 03.64 as the most up-to-date set of proposed specifications necessary to apply Chen's teachings to the then-prevailing GSM standard, including the newly-defined MCS-6 and MCS-9 schemes." *Id.* at 26 (citing Ex. 1023 ¶ 50).

Petitioner also disputes Patent Owner's argument that Eriksson fails to disclose a second puncturing pattern and further disputes that Eriksson "'disparages the use of a second puncturing scheme'" based on its disclosure "that a second puncturing scheme 'complicates or inhibits' the process of

combining 'and should thus only be done when absolutely necessary'" because Petitioner contends that "Patent Owner erroneously relies on a discussion about ***resegmentation*** of a data block, rather than ***puncturing*** . . . ." *Id.* at 27–28 (citing Ex. 1004, 940 ("[I]n fact, in IR operation, ***resegmentation*** of a datablock complicates or inhibits the IR combining and should thus only be done when absolutely necessary."); Prelim. Resp. 19–20).

Finally, Petitioner disputes that Patent Owner identifies any shortcoming in GSM 03.64 because Petitioner contends that GSM 03.64 does, in fact, address combining blocks in an IR scheme, contrary to Patent Owner's assertions. *Id.* at 28–29 (citing Prelim. Resp. 22–23; Ex. 1023 ¶ 46; Ex. 1002 ¶¶ 69–83; Ex. 1005, 39; Ex. 1024, 94:22–95:5 (Mr. Bates testifying that GSM 03.64 "discloses the use of an incremental redundancy scheme" and that GSM 03.64 "does say it combines them with the retransmitted RLC data blocks").

d) Analysis of Petitioner's Rationale for Combining

Petitioner's *first*, *second*, and *third* reasons essentially constitute an argument that Chen, Eriksson, and GSM 03.64 are capable of being combined because they are directed to analogous art, are in the same field of endeavor, and address the same problems. The parties do not present post-institution arguments regarding these reasons. Having reviewed the entirety of the record developed during trial, we are not persuaded to change our institution determination that these reasons are insufficient. Inst. Dec. 41–44.

As we explained in our Institution Decision, even assuming, *arguendo*, that these prior art references are analogous to each other or solve a common problem in the field of endeavor, this does not suffice as an

articulated reason with rational underpinning to combine their respective teachings—more is required to support the legal conclusion of obviousness. *See KSR*, 550 U.S. at 418. The Federal Circuit has concluded that merely asserting that two references "were drawn from the same general field of art the skilled artisan would have turned to them to solve the problems identified in the [challenged] Patent" is "simply too conclusory to satisfy [a Petitioner's] burden of proving by a preponderance of the evidence that the skilled artisan would have combined these references in the way of the claimed invention." *Securus Techs., Inc. v. Glob. Tel*Link Corp.*, 701 F. App'x 971, 976 (Fed. Cir. 2017); *see Microsoft Corp. v. Enfish, LLC*, 662 F. App'x 981, 990 (Fed. Cir. 2016) ("[The] Board correctly concluded that [petitioner] did not articulate a sufficient motivation to combine. With respect to [certain challenged claims, petitioner] gave no reason for the motivation of a person of ordinary skill to combine [the two references] except that the references were directed to the same art or same techniques . . . ."). Accordingly, Petitioner's contention that the references are similar, even if true, is insufficient to show why the skilled artisan would have combined Chen and Eriksson, as well as Chen and GSM 03.64, as set forth in the Petition.

Petitioner's *fourth*, *fifth*, and *sixth* reasons are similarly conclusory. Even assuming, *arguendo*, that Chen's teachings could have been applicable, relevant, useful, appealing, or "natural for a POSITA to combine" with other standards or schemes, such as, for example, GSM 03.64, this does not suffice as an articulated reason with a rational underpinning to combine the respective teachings of the references. *See KSR*, 550 U.S. at 418.

During oral argument, Petitioner referred to its *fourth* reason for combining the references as "market demand." Tr. 31:4–7. Even assuming, *arguendo*, that the record includes evidence supporting Petitioner's market demand arguments, the alleged market demand is with respect to the demand and industry adoption of GSM—not the demand for the combined teachings, in particular, the adoption of Chen's teachings in GSM 03.64 or for GSM in Chen's teachings. In support of Petitioner's market demand arguments, Dr. Kakaes testifies that

> A POSITA would have further been looking for opportunities to improve the GSM technical specifications because GSM was in a period of transition with new technical standards for the General Packet Radio Services (GPRS) and Evolved GPRS (EGPRS) being actively developed. GSM had recently announced that it was adding the new 8PSK modulation and coding schemes, making this a particularly good time to look for opportunities to use these new modulation and coding schemes (MCSs). To the extent Chen had emphasized the advantages of the spread spectrum modulation techniques of CDMA over TDMA, the introduction of GSM's new 8PSK modulation and new modulation and coding schemes in Eriksson and GSM 03.64 would have motivated a POSITA to combine Chen's teachings with each of Eriksson and GSM 03.64 in particular.

Ex. 1023 ¶ 47 (citing Ex. 1001, 1:18–31).

We discern that Petitioner's contentions and Dr. Kakaes's supporting testimony are premised on the position that because GSM technical specifications added new modulation and coding schemes, it would have been obvious to a POSITA to include Chen's incremental redundancy teachings. We are not persuaded by this position as it is generic, conclusory, and not sufficiently supported—Dr. Kakaes's supporting testimony could apply to *any* incremental redundancy retransmission method, not just that disclosed in Chen. Furthermore, the entire record further does not support a

finding that that Chen's alleged disclosure of methods for improving the efficiency of incremental redundancy techniques and throughput rates would have been understood, for example, to be above and beyond the efficiency and throughput rate of the teachings of GSM 03.64 alone.

Petitioner's *fourth* reason asserting that "Chen's disclosure of methods for improving the efficiency of incremental redundancy techniques to improve throughput rate would have appealed to a POSITA who would understand the relevance of Chen's teachings to incremental redundancy in the newly-added EGPRS schemes" is unclear as to whether Petitioner is arguing that Chen modifies Eriksson or GSM 03.64, or vice versa. *Compare* Pet. 72 (citing Ex. 1002 ¶¶ 337–338); Pet. Reply 24, *with* Pet. 73 (citing Ex. 1002 ¶¶ 333–340) ("*Applying Eriksson and GSM 03.64's teachings to Chen* would have been applying known techniques to improve the similar incremental redundancy techniques already taught by Chen in the same manner." (emphasis added)).

Petitioner's *fifth* reason that "Chen cross-references a 2G standard known as 'IS-95A'" and, as such, "illustrates that it was common to look to standards as part of any discussion about cellular systems" is similarly unpersuasive. Pet. 72. We maintain our determination that, at best, Petitioner's reasons concern why a POSITA *could* have combined Chen with Eriksson or Chen with GSM 03.64, not why a POSITA *would* have combined the references. *Belden Inc. v. Berk-Tek LLC*, 805 F.3d 1064, 1073 (Fed. Cir. 2015) ("[O]bviousness concerns whether a skilled artisan not only *could have made but would have been motivated to make* the combinations or modifications of prior art to arrive at the claimed invention."); *In re Giannelli*, 739 F.3d 1375, 1380 (Fed. Cir. 2014) ("[T]he mere capability of pulling the handles is not the inquiry that the Board should have made; it

should have determined whether it would have been obvious to modify the prior art apparatus to arrive at the claimed rowing machine.").

With respect to Petitioner's *sixth* reason that combining Chen with Eriksson or GSM 03.64 constitutes "applying known techniques to improve . . . similar incremental redundancy techniques" and Petitioner's *seventh*, *eighth*, and *ninth* reasons (Pet. 79–81) discussed in further detail below, the record *still* lacks clarity as to how Petitioner contends Chen is modified and/or improved by Eriksson or GSM 03.64 or *how* Chen itself modifies and/or improves Eriksson and GSM 03.64, respectively, despite Petitioner having had the opportunity, post-institution, to address this deficiency.

With respect to Petitioner's *seventh*, *eighth*, and *ninth* reasons, Petitioner relies on all three of Chen, Eriksson, and GSM 03.64 to teach each element of independent claim 1 (*id.* at 73–83), without explaining which reference's teaching is being used to modify which other reference. Moreover, Petitioner asserts that "Eriksson or GSM 03.64 . . . could supply all limitations except for potentially some of the means-plus-function elements, to invalidate the '561 claims" (*id.* at 71), but does not even indicate which means-plus-function elements Eriksson or GSM 03.64 "potentially" could not supply. As such, the Petition lacks clarity in identifying which teachings of Eriksson and GSM 03.64 reflect such "known techniques." *See Adaptics Ltd. v. Perfect Co.*, IPR2018-01596, Paper 20 (PTAB Mar. 6, 2019) (informative) (denying institution where the Petition failed to identify the challenges with particularity). Notwithstanding this lack of clarity, we address both the combination of Chen and Eriksson and the combination of Chen and GSM 03.64.

Chen discloses *increasing* the code rate by using a punctured code that transmits fewer code symbols for retransmitted data blocks than are

transmitted for originally-transmitted data blocks (Ex. 1003, 14:30–37) and, as such, Petitioner's reasoning that a POSITA would have looked to *Eriksson or GSM 03.64* to *increase* the code rates because of the benefits of the same (*see* Pet. 79–81) is unclear. As Chen discloses increased puncturing for increased code rates, it is possible that inventors of Chen appreciated the benefits associated with incremental redundancy, link adaption, and increased code rate granularity without needing to look to Eriksson or GSM 03.64.

Although Petitioner explains why the general concept of an increased code rate might be beneficial, Petitioner's *seventh* reason that "[a] POSITA would be motivated to increase the code rate in view of Eriksson's teachings about the benefits of increased code rate granularity and adaptation to channel conditions" is unclear as to whether it is Chen's code rate that is being increased and why Eriksson's code rates are an improvement to that of Chen, particularly in light of Chen's disclosure that its retransmission is sent with a higher code rate than its original transmission. Pet. 79 (citing Ex. 1004, 1–2, 5). Further, the purported benefits and efficiency gains of Chen, the "uniquely good fit" of "GSM's new spread spectrum MCSs" for Chen's teachings in view of "Chen's support for CDMA's spread spectrum modulation techniques," and/or the ease of implementing Chen's method in "radio systems compliant with GSM's GPRS and EGPRS specifications" are unpersuasive because there is insufficient evidence of record to support a finding that a POSITA would have understood that the combinations would result in any particular improvement over the increased code rates and incremental redundancy that Petitioner *also contends that GSM 03.64 discloses*. Pet. Reply 24 (citing Ex. 1002 ¶¶ 46–47; Ex. 1023 ¶ 48) (emphasis added); *see id.* at 28–29 (citing Prelim. Resp. 22–23; Ex. 1023 ¶

46; Ex. 1002 ¶¶ 69–83; Ex. 1005, 39; Ex. 1024, 94:22–95:5 (Mr. Bates testifying GSM 03.64 "discloses the use of an incremental redundancy scheme" and "does say it combines them with the retransmitted RLC data blocks")).

With respect to Petitioner's *eighth* reason, we more particularly determine that it is not clear that the second MCS is that of Chen or Eriksson or GSM 03.64. *Id.* at 80–81 (citing Ex. 1002 ¶¶ 535–538, 613; Ex. 1004, 3). A similar lack of clarity exists with respect to Petitioner's *ninth* contention and whether the referenced "second, different puncturing pattern" is that of Chen, Eriksson, or GSM 03.64. *Id.* at 81 (citing Ex. 1002 ¶¶ 531–540, 606–614).

With respect to Petitioner's *tenth* reason, we are also not persuaded. The finite number of "identified predictable combinations" asserted by Petitioner concerns the number of Eriksson's modulation and coding schemes—it is not clear how the finite number pertains to Chen's particular "incremental redundancy" method. In fact, it appears that Eriksson and GSM 03.64 disclose substantially similar incremental redundancy strategies in which the code rate of the retransmission can increase the code rate of the overall transmission. *See also* Pet. 71 (contending that each of Chen, Eriksson, and GSM 03.64 individually disclose the limitations of the claims). To the extent that the Petition could even be considered to indicate how it relies on the references in its third and fourth challenges, it appears that Petitioner's tenth reason cites Eriksson and/or GSM 03.64 to teach the applicability of 8PSK MCSs to the claims, in particular to dependent claims 4 and 8, which specify particular MCSs defined by EGPRS—*not* a reason to combine Chen and Eriksson or Chen and GSM 03.64. *Id.* at 86–89.

For the foregoing reasons, Petitioner's reasons, individually or collectively, do not sufficiently explain how or why a POSITA would have combined Chen and Eriksson, or Chen and GSM 03.64 and, therefore, lack sufficient rational underpinning. As such, Petitioner does not establish unpatentability of claims 1–10 over Chen and Eriksson by a preponderance of the evidence. Nor does Petitioner establish unpatentability of claims 1–10 over Chen and GSM 03.64 by a preponderance of the evidence.

Independently of Petitioner's deficient rationale for combining, with respect to independent claims 5 and 10 in particular, we determine that the "means for detecting" is lacking in identified structure corresponding to the "detecting" function. *Supra* § III.C. As we are unable to conclude what structure is encompassed by the "means for detecting," we cannot reach a conclusion as to whether the combination of Chen and Eriksson or the combination of Chen and GSM 03.64 teaches or suggests this claim term, or the subject matter of independent claims 5 and 10. For this *additional* reason, we are not persuaded that Petitioner establishes unpatentability of independent claims 5 and 10 by a preponderance of the evidence, either over Chen and Eriksson or over Chen and GSM 03.64.

As claims 6–8 depend from independent claim 5, we further determine, based on the entire record developed during trial, that Petitioner does not establish that these claims are unpatentable as obvious over the combination of Chen and Eriksson or the combination of Chen and GSM 03.64, by a preponderance of the evidence.

IV. CONCLUSION

For the foregoing reasons, we conclude that Petitioner establishes unpatentability of claims 1–3 and 9 of the '561 patent by a preponderance of

the evidence.[12] We conclude that Petitioner does not establish unpatentability of claims 4–8 and 10 by a preponderance of the evidence. Our conclusion regarding the challenged claims is summarized in the chart below:

Claim(s) Challenged	35 U.S.C. §	Reference(s)/Basis	Claims Shown Unpatentable	Claims Not Shown Unpatentable
1–3, 5–7, 9, 10[13]	102	Chen		5–7, 10
1–3, 5–7, 9, 10	103	Chen	1–3, 9	5–7, 10
1–10	103	Chen, Eriksson		1–10

[12] Should Patent Owner wish to pursue amendment of the challenged claims in a reissue or reexamination proceeding subsequent to the issuance of this decision, we draw Patent Owner's attention to the April 2019 *Notice Regarding Options for Amendments by Patent Owner Through Reissue or Reexamination During a Pending AIA Trial Proceeding. See* 84 Fed. Reg. 16,654 (Apr. 22, 2019). If Patent Owner chooses to file a reissue application or a request for reexamination of the challenged patent, we remind Patent Owner of its continuing obligation to notify the Board of any such related matters in updated mandatory notices. *See* 37 C.F.R. §§ 42.8(a)(3), (b)(2).

[13] We need not and do not reach whether claims 1–3 and 9 are anticipated by Chen because we determine that these claims are obvious over Chen. In final written decisions both before and after *SAS Inst., Inc. v. Iancu*, 138 S. Ct. 1348 (2018), the Board has declined to reach grounds challenging claims that were already held unpatentable. *See, e.g.*, *Sure-Fire Elec. Corp. v. Yongjiang Yin*, IPR2014-01448, Paper 56 at 25 (PTAB Feb. 22, 2016), *aff'd*, 702 F. App'x 981 (Fed. Cir. 2017); *SK Hynix Inc. v. Netlist, Inc.*, IPR2017-00692, Paper 25 at 40 (PTAB July 5, 2018). The Federal Circuit has acknowledged the Board's discretion in this regard. *See Boston Sci. Scimed, Inc. v. Cook Grp. Inc.*, Nos. 2019-1594, -1604, -1605, 2020 WL 2071962, at *4 (Fed. Cir. Apr. 30, 2020) (non-precedential) (recognizing that the "Board need not address issues that are not necessary to the resolution of the proceeding" and, thus, agreeing that the Board has "discretion to decline to decide additional instituted grounds once the petitioner has prevailed on all its challenged claims").

Claim(s) Challenged	35 U.S.C. §	Reference(s)/Basis	Claims Shown Unpatentable	Claims Not Shown Unpatentable
1–10	103	Chen, GSM 03.64		1–10
Overall Outcome			1–3, 9	4–8, 10

V. ORDER

In consideration of the foregoing, it is hereby:

ORDERED that claims 1–3 and 9 of the ’561 patent are shown to be unpatentable by a preponderance of the evidence;

ORDERED that claims 4–8 and 10 of the ’561 patent are not shown to be unpatentable by a preponderance of the evidence; and

FURTHER ORDERED that, because this a Final Written Decision, parties to this proceeding seeking judicial review of this Decision must comply with the notice and service requirements of 37 C.F.R. § 90.2.

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US006529561B2

(12) **United States Patent**
Sipola

(10) **Patent No.: US 6,529,561 B2**
(45) **Date of Patent: Mar. 4, 2003**

(54) **DATA TRANSMISSION IN RADIO SYSTEM**

(75) Inventor: **Jussi Sipola**, Oulu (FI)

(73) Assignee: **Nokia Networks Oy**, Espoo (FI)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/852,298**

(22) Filed: **May 10, 2001**

(65) **Prior Publication Data**

US 2002/0009157 A1 Jan. 24, 2002

Related U.S. Application Data

(63) Continuation of application No. PCT/FI00/00755, filed on Sep. 7, 2000.

(30) **Foreign Application Priority Data**

Sep. 10, 1999 (FI) 19991932

(51) **Int. Cl.**[7] **H04L 27/20**

(52) **U.S. Cl.** **375/295**; 375/240.27; 714/755; 714/748

(58) **Field of Search** 375/295, 240.24, 375/240.27; 714/755, 788, 748, 751, 752, 761, 762

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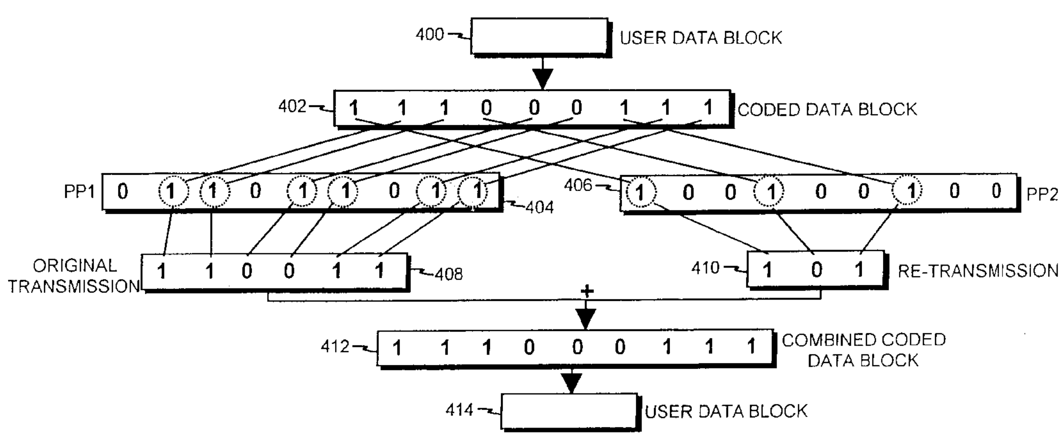
(List continued on next page.)

Primary Examiner—Stephen Chin
Assistant Examiner—Kevin Kim
(74) *Attorney, Agent, or Firm*—Pillsbury Winthrop LLP

(57) **ABSTRACT**

The invention relates to a method of transmitting data in a radio system from a transmitter to a receiver, and to a radio system using the method, a radio transmitter and a radio receiver. A transmitter **(260)** comprises a channel coder **(202)** for channel coding a data block into a coded data block by using a selected channel coding and for puncturing the coded data block by using a first puncturing pattern, and transmission means **(204)** for transmitting the coded data block punctured by the first puncturing pattern to a receiver **(264)**. The receiver **(264)** comprises a channel decoder **(218)** for decoding the received coded data block, means **(224)** for detecting a need for retransmission of the received coded data block, and means **(204)** for transmitting a retransmission request of the coded data block to the transmitter **(260)**. The channel coder **(202)** increases the code rate of the coded data block to be retransmitted by puncturing the coded data block coded by the channel coding of the original transmission by using a second puncturing pattern comprising fewer symbols to be transmitted than the first puncturing pattern. The transmission means **(204)** transmit the coded data block punctured by the second puncturing pattern to the receiver **(264)**. The receiver **(264)** comprises means **(222)** for combining a received coded data block **(216)** punctured by the first puncturing pattern and a received coded data block **(220)** punctured by the second puncturing pattern. The channel decoder **(218)** decodes the channel coding of the combined coded data block.

10 Claims, 6 Drawing Sheets



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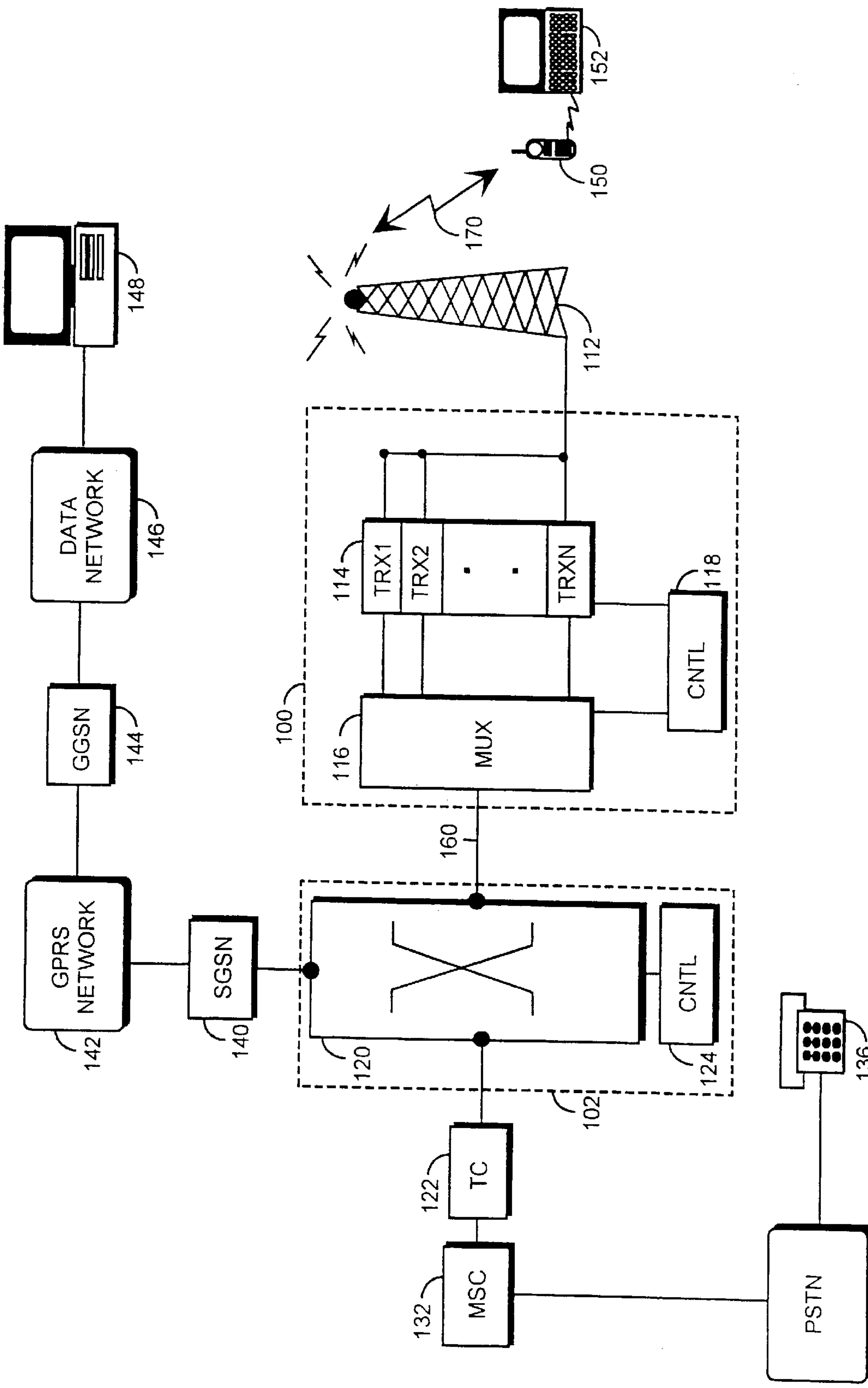
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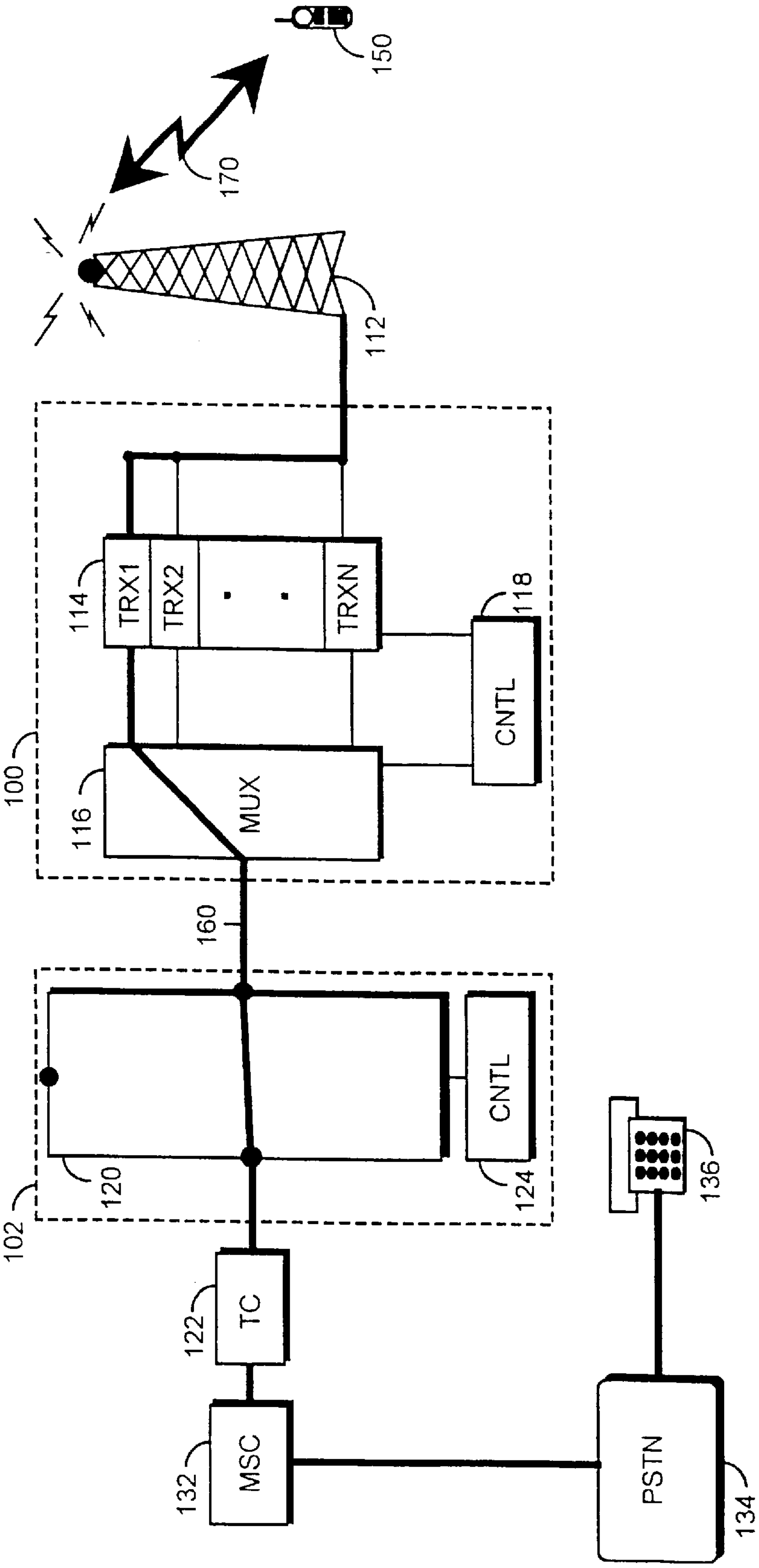
150
170
148
112
DATA NETWORK
146
TRX1
TRX2
TRXN
114
118
CNTL
GGSN
144
100
116
MUX
160
GPRS NETWORK
SGSN
CNTL
142
140
120
124
136
102
TC
122
MSC
132
PSTN
134

Fig 1A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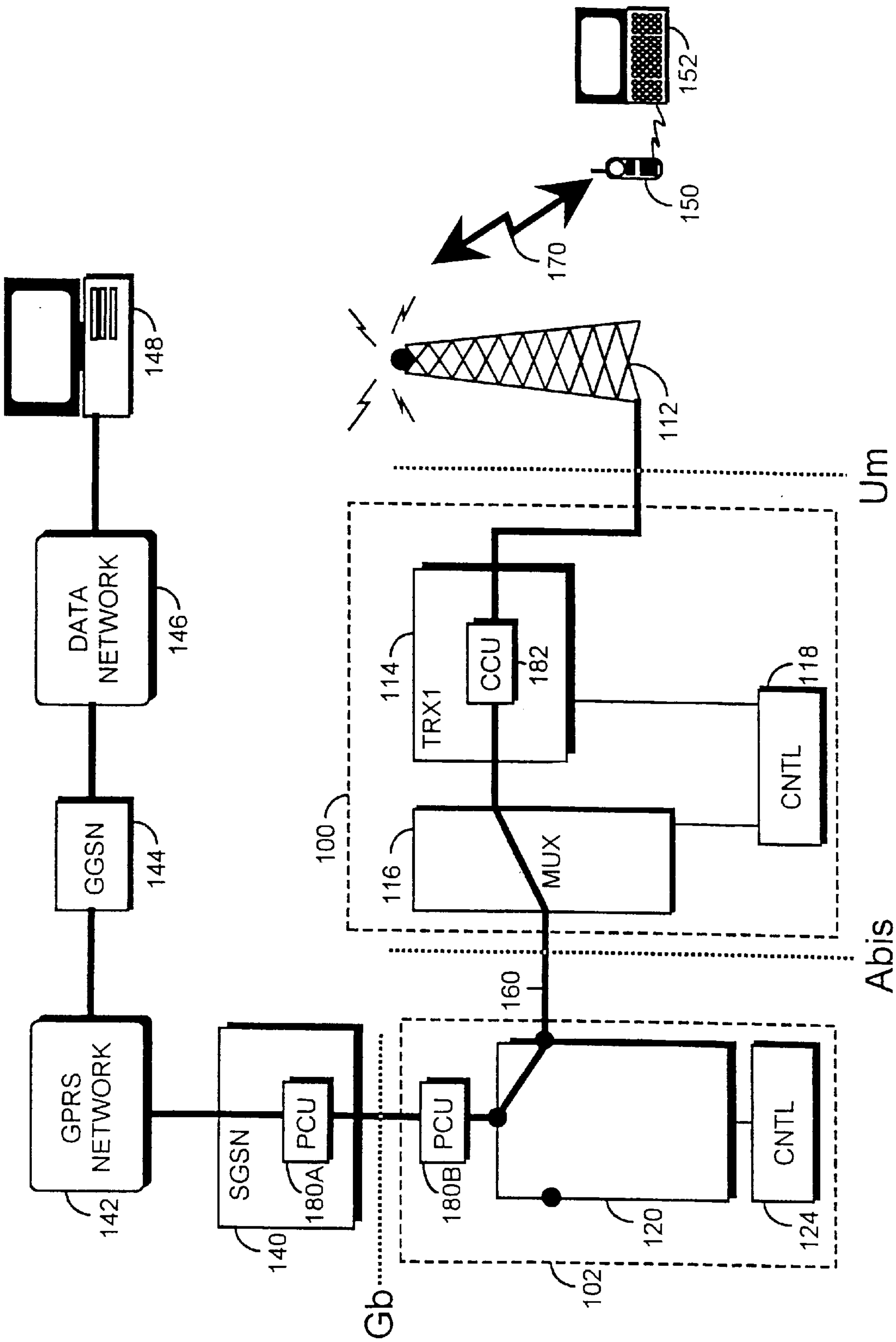
TC
132
MSC
PSTN
134

Fig 1B


GPRS NETWORK
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GGSN
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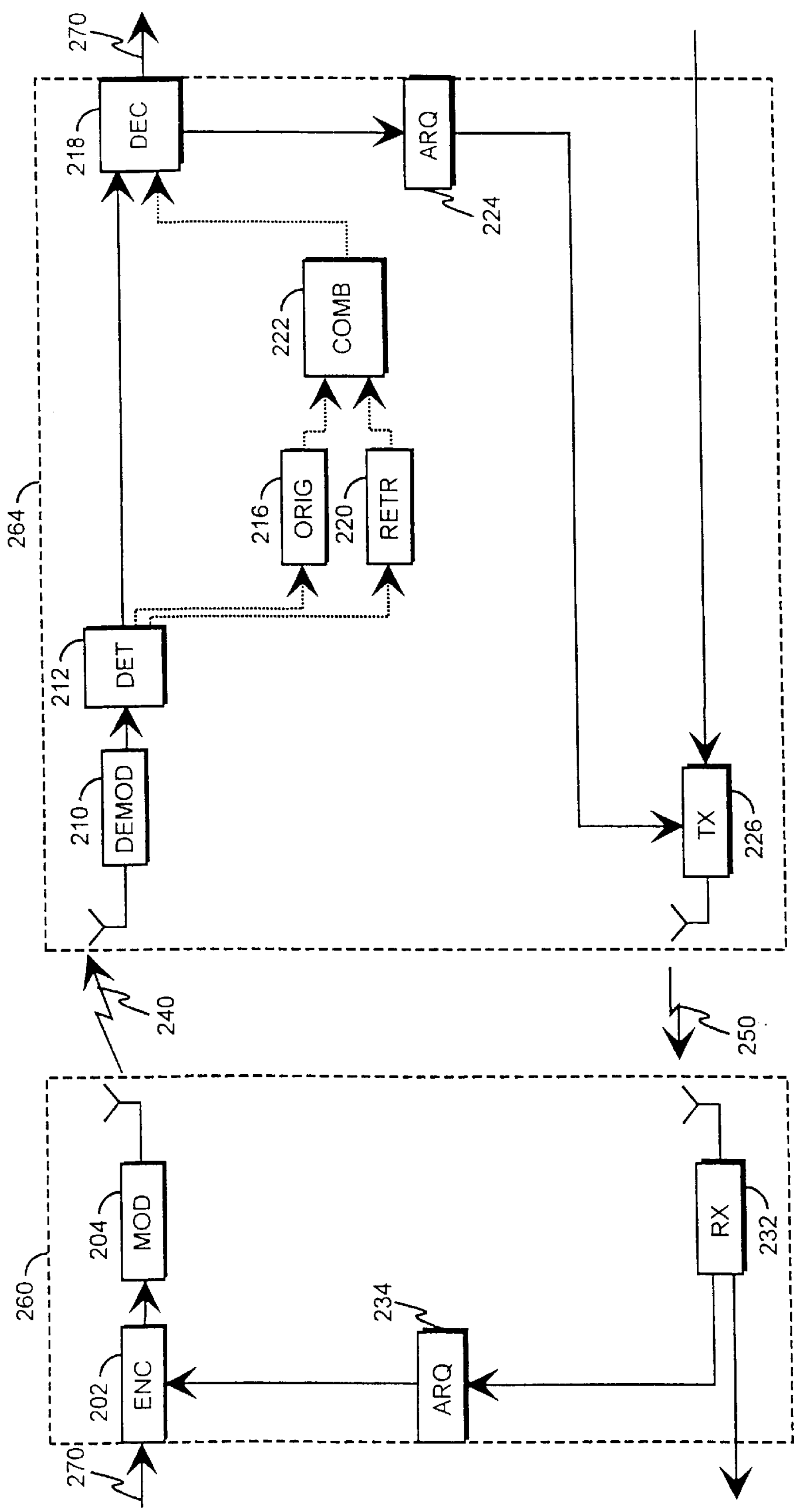
DATA NETWORK
146
148
SGSN
140
PCU
180A
Gb
PCU
180B
120
CNTL
124
102
160
Abis
MUX
116
100
TRX1
114
CCU
182
CNTL
118
Um
112
170
150
152

Fig 1C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DEC
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ARQ
224
COMB
222
264
ORIG
216
RETR
220
DET
212
DEMOD
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TX
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MOD
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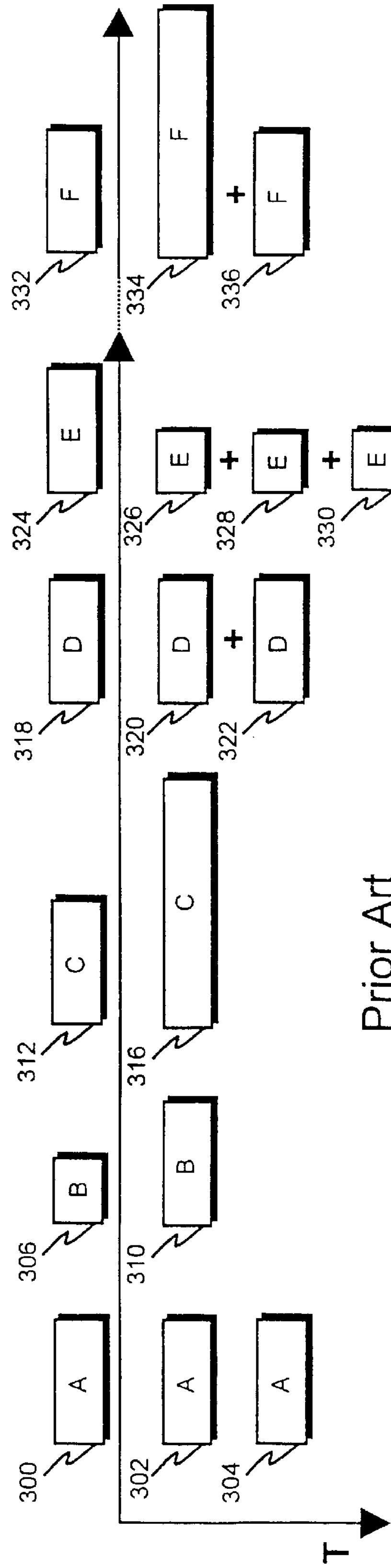
RX
232
234
ENC
202
ARQ
270

Fig 2



Prior Art
Fig 3A

Fig 3B

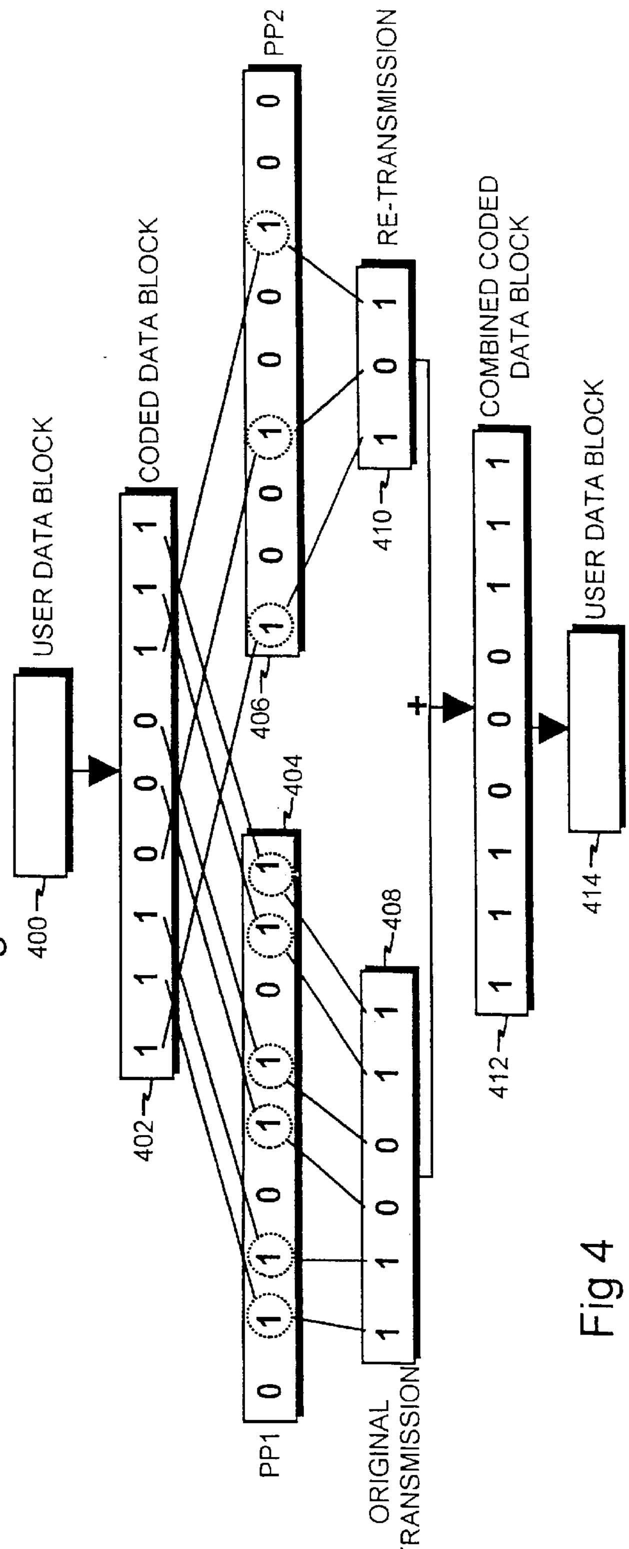


Fig 4

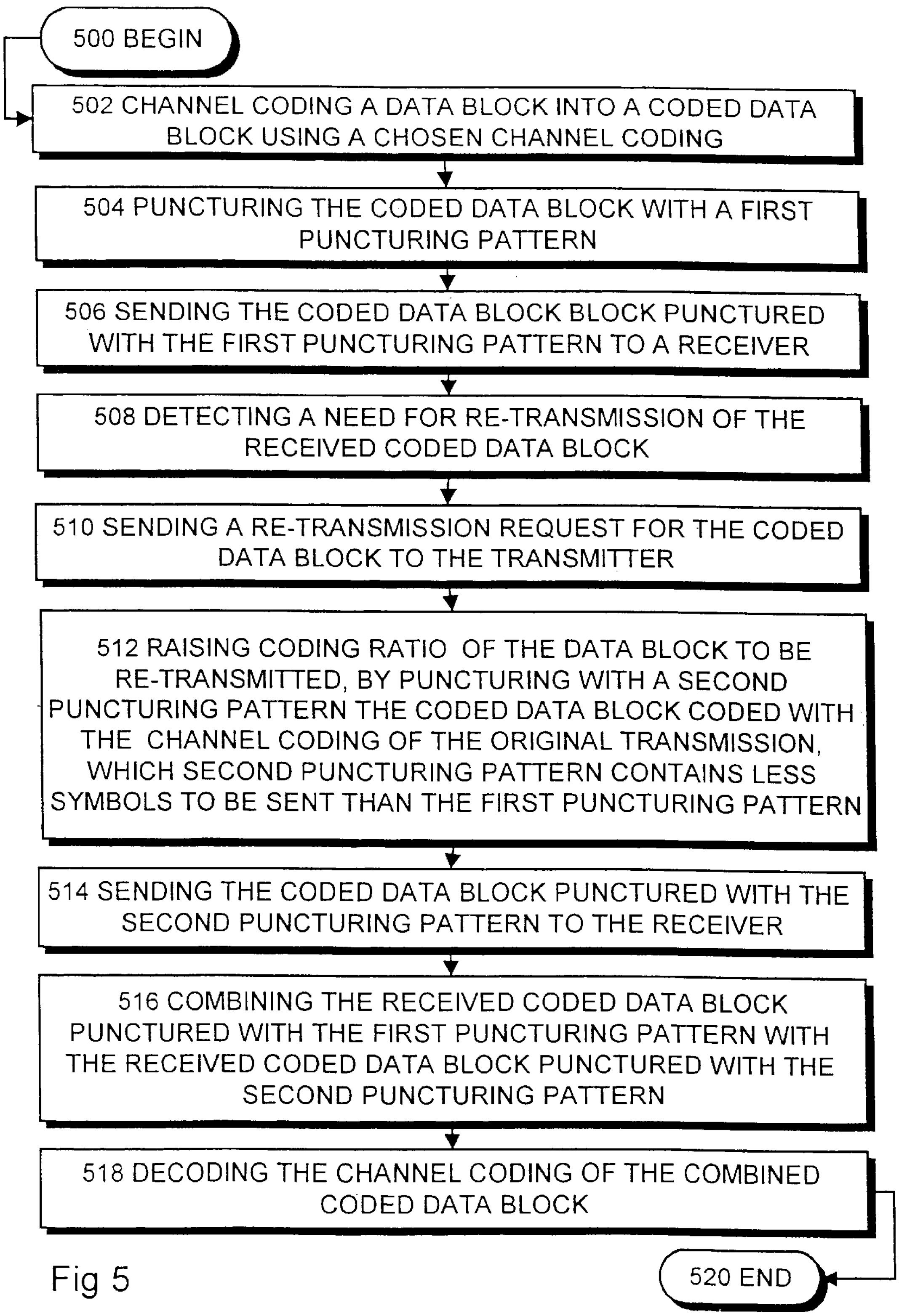

500 BEGIN
502 CHANNEL CODING A DATA BLOCK INTO A CODED DATA BLOCK USING A CHOSEN CHANNEL CODING
504 PUNCTURING THE CODED DATA BLOCK WITH A FIRST PUNCTURING PATTERN
506 SENDING THE CODED DATA BLOCK BLOCK PUNCTURED WITH THE FIRST PUNCTURING PATTERN TO A RECEIVER
508 DETECTING A NEED FOR RE-TRANSMISSION OF THE RECEIVED CODED DATA BLOCK
510 SENDING A RE-TRANSMISSION REQUEST FOR THE CODED DATA BLOCK TO THE TRANSMITTER
512 RAISING CODING RATIO OF THE DATA BLOCK TO BE RE-TRANSMITTED, BY PUNCTURING WITH A SECOND PUNCTURING PATTERN THE CODED DATA BLOCK CODED WITH THE CHANNEL CODING OF THE ORIGINAL TRANSMISSION, WHICH SECOND PUNCTURING PATTERN CONTAINS LESS SYMBOLS TO BE SENT THAN THE FIRST PUNCTURING PATTERN
514 SENDING THE CODED DATA BLOCK PUNCTURED WITH THE SECOND PUNCTURING PATTERN TO THE RECEIVER
516 COMBINING THE RECEIVED CODED DATA BLOCK PUNCTURED WITH THE FIRST PUNCTURING PATTERN WITH THE RECEIVED CODED DATA BLOCK PUNCTURED WITH THE SECOND PUNCTURING PATTERN
518 DECODING THE CHANNEL CODING OF THE COMBINED CODED DATA BLOCK
520 END

Fig 5

DATA TRANSMISSION IN RADIO SYSTEM

This application is a continuation of international patent application No. PCT/FI00/00755 filed Sep. 7, 2000, which designated the United States, and that international patent application was published under PCT Article 21(2) in English.

FIELD OF THE INVENTION

The invention relates to a method of transmitting data in a radio system from a transmitter to a receiver, and to a radio system, a radio transmitter and a radio receiver using the method. The use of the method is described in EGPRS (Enhanced General Packet Radio Service).

BACKGROUND OF THE INVENTION

EGPRS (Enhanced General Packet Radio Service) is a system based on GSM (Global System for Mobile Communications) utilising packet- switched transmission. EGPRS employs EDGE (Enhanced Data Rates for GSM Evolution) technique in order to increase data transmission capacity. In addition to GMSK (Gaussian Minimum-Shift Keying) modulation normally used in the GSM, 8-PSK (8-Phase Shift Keying) modulation can be used for packet data channels. The purpose is mainly to implement non-realtime data transmission services, such as copying files and use of an Internet browser, but also real-time services as packet-switched services for transmitting speech and video, for example. In principle, data transmission capacity can vary from a few kbit/s up to 400 kbit/s.

Also other procedures are used in order to increase capacity, for example blind detection of modulation, link adaptation and incremental redundancy.

Blind detection of modulation means that it is not necessary to signal to a receiver which modulation method is being used but the receiver detects the modulation method when it receives a signal.

Link adaptation refers to changing the code rates of blocks to be transmitted on the basis of measurements carried out on the channel. The code rate can be changed between retransmissions of the same block. Another alternative is to change the code rate between successive blocks, provided, however, that all transmissions of a single block are coded by the same code rate. The purpose is to optimize the use of radio resources taking instantaneous variations in the conditions of the radio interface into account. The purpose is to optimize user data throughput and to minimize delay.

The code rate of a block refers to the ratio of the number of user data bits to the coded data bits of a channel. If, for example, 100 user data bits are coded into 200 data bits to be transmitted over the channel, the code rate obtained is 100/200=½.

FIG. **3**A shows examples of changing the code rate of a block. In FIG. **3**A, a data block to be transmitted is shown above the X-axis, and blocks transmitted actually over the radio link are shown below the X-axis. The Y-axis denotes passage of time. Block sizes are scaled in accordance with each other, i.e. the larger the block, the more bits to be transmitted said block comprises.

A block A **300** is to be transmitted over the radio link. First transmission **302** fails, so the transmission is repeated **304**. Link adaptation was not carried out, since as can be seen from FIG. **3**A, the blocks **302**, **304** are equal in size. The code rate in both transmissions **302**, **304** is **1**.

In comparison with the transmission of the block A **300**, link adaptation is carried out in the transmission of a block B **306** by changing the amount of user data. Compared with the block A **300**, it is detected that the size of the block B **306** is reduced by half. The code rate of a block **310** to be transmitted has been reduced to ½.

Another way to carry out link adaptation is to change the size of a data block to be transmitted over the radio link. Compared with the transmission of the block A **300**, in the transmission of a block C **312** link adaptation is carried out by changing the size of the data block to be transmitted. The code rate of a block **316** to be transmitted is ½since the size of the data block to be transmitted over the link has been doubled.

Under favourable conditions, for example, coding can be reduced, which means that more user payload can be transferred. Similarly, one modulation method can be better suited than the other to certain conditions on the radio interface. Different combinations of modulation and channel coding can be called modulation and coding schemes MCS.

If the coding conditions of a channel change extremely rapidly, it is impossible for the system to optimally select the code rate for the forthcoming transmission in advance. Incremental redundancy enables better adaptation to changing conditions. In incremental redundancy, a receiver is equipped with a memory to store the bits of radio blocks that have been received erroneously. Retransmitted radio blocks are then combined with the stored radio blocks, whereafter the receiver attempts to decode the block. Since there are more coded channel data bits to be used for decoding after the combining and the number of user data bits remains the same, the effective code rate of the block is decreased after retransmission, which makes decoding more feasible. An example of such a protocol is the hybrid FEC/ARQ (Forward Error Correction/Automatic Repeat Request), which uses error correction coding in order to decrease the number of retransmissions.

The effective code rate of the channel is adapted automatically since the channel conditions determine the number of necessary retransmissions, which in turn determines the code rate. FIG. **3**A shows the simplest retransmission method for a data block D **318** to be transmitted. An original transmission **320** is carried out by a code rate **1**, and a first retransmission **322** also by a code rate **1**. After the first retransmission the code rate of the combined data block is ½. A second retransmission would yield a code rate ⅓, a third retransmission a code rate ¼, and this could be continued until it would be possible to decode the combined data block.

The problem with the retransmission method disclosed is that the effective code rates are quantized with relatively large steps: after one retransmission the code rate is only half of the original. This means that the capacity of the system is wasted since a smaller reduction in the code rate would often be sufficient. A solution that has been provided discloses a method wherein the data block to be transmitted is divided into sub-blocks, for example into two sub-blocks, the number of the sub-blocks being denoted by D, which is described in FIG. **3**A by a block E **324**. The code rate used in the transmission of an original block **326** is **2**. After a first retransmission **328** the code rate is **1**, after a second retransmission **330** the code rate is ⅔, after a third retransmission the code rate would be ½, after a fourth retransmission the code rate would be ⅖. The drawback of this method is that even under ideal channel conditions transmission of at least D data block(s) is necessary before the data block can be decoded, i.e. the code rate must be 1 at most.

BRIEF DESCRIPTION OF THE INVENTION

An object of the invention is thus to provide a method and an apparatus implementing the method so as to enable efficient simultaneous utilization of link adaptation and incremental redundancy. This is achieved by the method disclosed below of transmitting data in a radio system from a transmitter to a receiver, the method comprising: channel coding a data block into a coded data block by using a selected channel coding; puncturing the coded data block by using a first puncturing pattern; transmitting the coded data block punctured by the first puncturing pattern to the receiver; detecting a need for retransmission of the received coded data block; transmitting a retransmission request of the coded data block to the transmitter. The method further comprises: increasing the code rate of the coded data block to be retransmitted by puncturing the coded data block coded by the channel coding of the original transmission by using a second puncturing pattern comprising fewer symbols to be transmitted than the first puncturing pattern; transmitting the coded data block punctured by the second puncturing pattern to the receiver; combining the received coded data block punctured by the first puncturing pattern and the received coded data block punctured by the second puncturing pattern; and decoding the channel coding of the combined coded data block.

The invention also relates to a radio system comprising: a transmitter and a receiver having a radio connection to the transmitter; the transmitter comprising a channel coder for channel coding a data block into a coded data block by using a selected channel coding and for puncturing the coded data block by using a first puncturing pattern, and transmission means for transmitting the coded data block punctured by the first puncturing pattern to the receiver; the receiver comprising a channel decoder for decoding the received coded data block, means for detecting a need for retransmission of the received coded data block, and means for transmitting a retransmission request of the coded data block to the transmitter. The channel coder increases the code rate of the coded data block to be retransmitted by puncturing the coded data block coded by the channel coding of the original transmission by using a second puncturing pattern comprising fewer symbols to be transmitted than the first puncturing pattern; the transmission means transmit the coded data block punctured by the second puncturing pattern to the receiver; the receiver comprises means for combining a received coded data block punctured by the first puncturing pattern and a received coded data block punctured by the second puncturing pattern; the channel decoder decodes the channel coding of the combined coded data block.

The invention further relates to a radio transmitter comprising: a channel coder for channel coding a data block into a coded data block by using a selected channel coding and for puncturing the coded data block by using a first puncturing pattern; transmission means for transmitting the coded data block punctured by the first puncturing pattern to a receiver; means for receiving a retransmission request of the coded data block. The channel coder increases the code rate of the coded data block to be retransmitted by puncturing the coded data block coded by the channel coding of the original transmission by using a second puncturing pattern comprising fewer symbols to be transmitted than the first puncturing pattern; the transmission means transmit the coded data block punctured by the second puncturing pattern to the receiver.

The invention still further relates to a radio receiver comprising: reception means for receiving a coded data

block channel-coded by a selected channel coding and punctured by a first puncturing pattern; a channel decoder for decoding the received coded data block; means for detecting a need for retransmission of the received coded data block; means for transmitting a retransmission request of the coded data block to a transmitter. The reception means receive the retransmitted coded data block whose code rate has been increased by puncturing the coded data block coded by the channel coding of the original transmission by using a second puncturing pattern comprising fewer symbols to be transmitted than the first puncturing pattern; means for combining the received coded data block punctured by the first puncturing pattern and the received coded data block punctured by the second puncturing pattern; a channel coder decodes the channel coding of the combined coded data block.

The preferred embodiments of the invention are disclosed in the dependent claims.

The invention is based on the idea that the same channel coding has been used in the coding of the originally transmitted data block and the retransmitted data block, and the code rates of the two transmissions are made to differ by using different puncturing. Hence, despite the different code rates, the data blocks can be combined.

The advantage achieved by the method and apparatus of the invention is that there is a sufficiently dense range of effective code rates to enable the code rate required by the channel conditions to be selected relatively accurately, which saves the valuable radio resource of the system.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is now described in closer detail in connection with the preferred embodiments with reference to the accompanying drawings, in which

FIG. **1**A is a block diagram of a cellular radio network,

FIG. **1**B shows a circuit-switched connection,

FIG. **1**C shows a packet-switched connection,

FIG. **2** is a simplified block diagram showing a transmitter and a receiver used in the invention,

FIG. **3**A shows known methods already described for implementing link adaptation and incremental redundancy,

FIG. **3**B shows how combined link adaptation and incremental redundancy are implemented in accordance with the invention,

FIG. **4** illustrates an example of combining an originally transmitted data block and a retransmitted data block in accordance with the invention, and

FIG. **5** is a flow diagram illustrating a data transmission method of the invention.

DETAILED DESCRIPTION OF THE INVENTION

Referring to FIG. **1**A, a typical structure of a radio system of the invention and its connections to a fixed telephone network and a packet transmission network will be described. FIG. **1**A only includes essential blocks for describing the invention, but it will be obvious to one skilled in the art that a common packet cellular radio network also includes other functions and structures that need not be described in closer detail here. The invention is most preferably used in EGPRS. The invention functions both on the uplink and the downlink.

A cellular radio network typically comprises the infrastructure of a fixed network, i.e. a network part and sub-

scriber terminals **150** that can be fixedly located, located in a vehicle or portable terminals to be carried around, for example. The network part comprises base stations **100**. Communicating with the several base stations **100**, a base station controller **102** in turn controls the base stations in a centralized manner. The base station **100** comprises transceivers **114**. The base station **100** typically comprises **1** to **16** transceivers **114**. One transceiver **114** provides one TDMA (Time Division Multiple Access) frame, i.e. typically eight time slots, with radio capacity.

The base station **100** comprises a control unit **118** controlling the operation of the transceivers **114** and a multiplexer **116**. The multiplexer **116** places the traffic channels and the controlling channels used by the plurality of transceivers **114** over one transmission link **160**. The structure of the transmission link **160** is clearly defined and it is called an Abis interface.

The transceivers **114** of the base station **100** communicate with an antenna unit **112** implementing a duplex radio connection **170** to the subscriber terminal **150**. Also in the duplex radio connection **170**, the structure of the frames to be transmitted is defined in detail, and it is called an air interface.

The subscriber terminal **150** can be a common mobile telephone, for example, to which a portable computer **152** can be connected by an extension card, which portable computer can be used in ordering and processing packets.

The base station controller **102** comprises a switching field **120** and a control unit **124**. The switching field **120** is used for switching speech and data and for connecting signalling circuits. The base station system comprising the base station **100** and the base station controller **102** further comprises a transcoder **122**. The transcoder **122** is usually located as close to a mobile services switching centre **132** as possible since speech can thus be transmitted in the form of cellular radio network between the transcoder **122** and the base station controller **102** by using as little transmission capacity as possible.

The transcoder **122** converts the different digital coding modes of speech used between a public telephone network and a mobile telephone network into compatible ones, for example from the 64 kbit/s form of the fixed network into another form (13 kbit/s, for example) and vice versa. The control unit **124** performs call control, mobility management, collection of statistical data and signalling.

As can be seen from FIG. **1**A, the switching field **120** can perform switching (depicted by black dots) to a public switched telephone network PSTN **134** via the mobile services switching centre **132** and to a packet transmission network **142**. A typical terminal **136** in the public switched telephone network **134** is a common telephone or an integrated services digital network ISDN telephone.

The connection between the packet transmission network **142** and the switching field **120** is established by a serving GPRS support node SGSN **140**. The serving GPRS support node **140** serves to transfer packets between the base station system and a gateway GPRS support node GGSN **144**, and to keep a record of the location of the subscriber terminal **150** in its area.

The gateway GPRS support node **144** connects the public packet transmission network **146** and the packet transmission network **142**. An Internet protocol or X.**25** protocol can be used on the interface. By encapsulation, the gateway GPRS support node **144** hides the internal structure of the packet transmission network **142** from the public packet transmission network **146**, so for the public packet transmission network **146** the packet transmission network **142** resembles a sub-network, the public packet transmission network **146** being able to address packets to the subscriber terminal **150** located therein and to receive packets therefrom.

The packet transmission network **142** is typically a private network which uses an Internet protocol carrying signalling and tunnelled use data. As regards the architecture and protocols below the Internet protocol layer, the structure of the network **142** may vary operator-specifically.

The public packet transmission network **146** can be a global Internet, for example, to which a terminal **148**, a server computer, for example, with a connection thereto wants to transfer packets to the subscriber terminal **150**.

FIG. **1**B shows how a circuit-switched transmission link is established between the subscriber terminal **150** and the terminal **136** of the public switched telephone network. The bold line in the figures denote how data travels through the system on the air interface **170**, from the antenna **112** to the transceiver **114** and from there, multiplexed at the multiplexer **116** along the transmission link **160** to the switching field **120**, where a connection is established to the output heading to the transcoder **122**, and from there onwards through the connection established in the mobile services switching centre **132** to the terminal **136** connected to the public switched telephone network **134**. In the base station **100** the control unit **118** controls the multiplexer **116** in the transmission, and in the base station controller **102** the control unit **124** controls the switching field **120** to carry out a correct connection.

FIG. **1**C shows a packet-switched transmission link. The portable computer **152** is now connected to the subscriber terminal **150**. The bold line denotes how data to be transferred travels from the server computer **148** to the portable computer **152**. Naturally, data can also be transferred in the opposite direction, i.e. from the portable computer **152** to the server computer **148**. Data travels through the system on the air interface **170**, i.e. the Um interface, from the antenna **112** to the transceiver **114** and from there, multiplexed in the multiplexer **116** along the transmission link **160** on the Abis interface to the switching field **120**, where a connection is established to the output heading to the serving GPRS support node **140** on the GB interface, from the serving GPRS support node **140** data is supplied along the packet transmission network **142** through the gateway GPRS support node **144** and is connected to the server computer **148** connected to the public packet transmission network **146**.

For the sake of clarity, FIGS. **1**B and **1**C do not describe a case wherein both circuit-switched and packet-switched data is transferred simultaneously. However, this is both feasible and common since the capacity free from circuit-switched data transmission can be flexibly used to implement packet-switched transmission. A network can also be built wherein circuit-switched data is not transferred at all, only packet data. In such a case, the structure of the network can be simplified.

Let us return to FIG. **1**C. The network part of the packet cellular radio network thus comprises the base station **100** and the transceiver **114** implementing the Um interface at the base station **100**.

In addition to the above, two specific elements are known in the GPRS: a channel codec unit CCU and a packet control unit PCU. The CCU is responsible for channel coding, including forward error coding FEC, and interleaving, radio channel measurement functions, such as quality level of a received signal, reception power of a received signal, and

information relating to measurements of timing advance. The tasks of the PCU include segmenting and re-assembling a logical link control LLC frame, automatic repeat request ARQ functions, scheduling a packet data channel PDCH, channel access control and radio channel management functions.

A CCU **182** is located in the base station **100** and, depending on the implementation, it can be regarded as a time-slot-specific or a transceiver -specific unit. A PCU **180**A/**180**B is connected to the CCU **182** through the Abis interface. The PCU can be located at the base station **100**, the base station controller **102** or the serving GPRS support node **140**. FIG. **1**C shows the PCU located at the base station controller **102** or the serving GPRS support node **140**, but for the sake of clarity the PCU is not shown located at the base station **100**.

Next, FIG. **5** shows the method of the invention for transmitting data in a radio system from a transmitter to a receiver. In addition, an example of FIG. **4** will be described. The method is initiated in block **500**.

In block **502**, a data block **400** is channel-coded into a coded data block **402** by using a selected channel coding. In the example of FIG. **4**, the data block **400** comprising user data is coded by a code rate ⅓, i.e. each data symbol is represented by three channel-coded symbols. For the sake of simplicity, it is assumed in the example that there are three user data symbols, in which case there are nine channel-coded symbols, i.e. a bit sequence 111000111. In the present application, channel coding refers to a known method of performing channel coding, for example block coding, convolutional coding or some coding method developed from convolutional coding, excluding, however, puncturing from channel coding.

Next, in block **504**, the coded data block **402** is punctured by using a first puncturing pattern **404**. Puncturing refers to removal coding, i.e. a procedure where the number of coded symbols is decreased by removing a certain number of symbols. The symbols to be removed can be defined by a puncturing pattern. In the example, the first puncturing pattern **404** comprises bits 011011011. The 0 bit denotes that the channel-coded symbol located at the point in question is removed, while the 1 bit is not removed. Hence, the first puncturing pattern **404** removes the first symbol and every third symbol thereafter. In a special case, the first puncturing pattern **404** can be such that it does not remove any symbol.

In block **506**, a coded data block **408** punctured by the first puncturing pattern **404** is transmitted to the receiver. In accordance with FIG. **4**, the punctured coded data block **408** used in this original transmission comprises symbols **110011**, i.e. the second, third, fifth, sixth, eighth and ninth original channel-coded symbol.

In block **508**, a need for retransmission of the received coded data block **408** is detected. The need for retransmission means that the receiver cannot decode the received data block **408**. This can be detected either by an error detection code or by the fact that an error correcting code cannot correct errors occurring on the channel with sufficient certainty.

In block **510**, a retransmission request of the coded data block is then transmitted to the transmitter. The retransmission request can be carried out as a negative acknowledgement NACK message, for example. Correspondingly, when no retransmission is needed any longer, an acknowledgement ACK message can be transmitted. This can be implemented in practice for example such that the CCU, after detecting an error, transmits a bad frame indicator to the PCU, and the PCU generates a NACK message which the PCU then transmits to the CCU to be transmitted to the radio path.

As a result from this retransmission request, the code rate of the coded data block to be retransmitted is increased in block **512** by puncturing the coded data block **402** coded by the channel coding of the original transmission by using a second puncturing pattern **406**. The second puncturing pattern **406** comprises fewer symbols to be transmitted than the first puncturing pattern **404**. In the example of FIG. **4**, the second puncturing pattern **406** comprises bits 100100100, i.e. only the first and the third symbol thereafter are retained, while other symbols are removed.

In block **514**, a coded data block **410** punctured by the second puncturing pattern **406** is transmitted to the receiver. In accordance with FIG. **4**, the punctured and coded data block **410** used in this retransmission comprises symbols **101**, i.e. the first, fourth, and seventh symbol of the original channel-coded block **402**.

Next, in block **516**, the received coded data block **408** punctured by the first puncturing pattern **404** and the received coded data block **410** punctured by the second puncturing pattern **406** are combined. The data blocks can be combined because both data blocks **408**, **410** are punctured versions of the same coded data block **402**. In the example of FIG. **4**, the second, third, fifth, sixth, eighth and ninth symbol of a combined coded data block **412** are obtained from the coded data block **408** punctured by the first puncturing pattern **404**, and the first, fourth and seventh symbol are obtained from the coded data block **410** punctured by the second puncturing pattern **406**. In the example, the puncturing patterns **404**, **406** are completely separate, i.e. no symbol of the coded data block **402** is present both in the punctured block **408** and the punctured block **410**. This is not necessary, however, but the same symbol of the coded data block **402** can occur in more than one punctured block **408**, **410**. It is, however, preferable that the symbols to be transmitted of the first puncturing pattern **404** and the second puncturing pattern **406** together comprise as many of the symbols of the coded data block **402** as possible.

Finally, the channel coding of the combined coded data block **412** is decoded in block **518**. When a Viterbi decoder is used for decoding the convolutional coding used as the channel coding, it is then more likely that the soft bit decisions of symbols that have received more energy are more certain, depending, of course, on the temporary circumstances on the channel. After the channel coding is decoded, a data block **414** comprising user data is obtained.

When the method is used it is preferable that the code rate of the punctured coded data block does not exceed 1. Then, under favourable circumstances, only the original transmission is required in order to carry out decoding successfully.

TABLE 1

MCS	Code Rate	Modulation	Number of Data Blocks in Radio Block	Amount of User Data in One Radio Block (Excluding Header)	Amount of Data in One Radio Block (Excluding Header)
MSC-9	1.0	8PSK	2	592 + 592	612 + 612
MCS-8	0.92	8PSK	2	544 + 544	612 + 612
MCS-7	0.76	8PSK	2	448 + 448	612 + 612
MCS-6	0.49	8PSK	1	592	1248
MCS-5	0.37	8PSK	1	448	1248

TABLE 1-continued

MCS	Code Rate	Modulation	Number of Data Blocks in Radio Block	Amount of User Data in One Radio Block (Excluding Header)	Amount of Data in One Radio Block (Excluding Header)
MCS-4	1.0	GMSK	1	352	372
MCS-3	0.80	GMSK	1	296	372
MCS-2	0.66	GMSK	1	224	372
MCS-1	0.53	GMSK	1	176	372

Table 1 shows different modulation and coding schemes MCS of EGPRS. Of each MCS, the code rate of its original transmission, modulation method used, number of data blocks in a radio block, amount of user data (in bits) in a radio block and the amount of coded data (in bits) in one radio block is disclosed.

A radio block is transmitted every 20 ms. The radio block can be modulated using GMSK, whereby the radio block comprises **464** raw bits, or then modulation can be carried out by using 8-PSK, whereby the radio block comprises 1392 raw bits. Modulation and coding schemes MCS-**7**, MCS-**8** and MCS-**9** comprise two coded data blocks in each radio block. The sizes of user data blocks are the same in MCS-**6** and MCS-**9**, and in MCS-**5** and MCS-**7**.

When the method of the invention is used, a preferable combination of the modulation and coding schemes used in EGPRS in an original transmission and in a retransmission is one of the following:

- modulation and coding scheme six MCS-**6** and modulation and coding scheme nine MCS-**9**,
- modulation and coding scheme five MCS-**5** and modulation and coding scheme seven MCS-**7**, and
- modulation and coding scheme six MCS-**6** using padding bits and modulation and coding scheme eight MCS-**8**.

Thus, the invention does not require any changes in the headers or in the structures of the data blocks.

In all modulation and coding schemes, convolutional coding is used at a code rate ⅓. For example when an original transmission is carried out by using MCS-**6**, after channel coding the 612 user bits (592 bits+header) are represented by 1836 bits, from which, after puncturing in accordance with the example of FIG. **4**, each user data symbol is represented by approximately two channel-coded symbols, i.e. 1250 bits. The code rate is thus 0.49. By using MCS-**9** in retransmission, the 612 user data symbols (including header) are represented by 1836 bits, from which, after puncturing in accordance with the example of FIG. **4**, 612 bits remain, i.e. the code rate is 1. The code rate of the combined data block obtained is 0.33, i.e. approximately ⅓. Indeed, the example of FIG. **4** roughly describes this combination of the modulation and coding schemes, simplified, however, to three user data symbols only. Based on what has been disclosed above, it is obvious to one skilled in the art how the method of the invention is applied to other combinations of modulation and coding schemes.

FIG. **3**B is a simplified schematic block diagram further showing how the method of the invention differs from the prior art. When a data block F **332** is to be transferred over the radio link, it can first **334** be transmitted at a certain code rate and a retransmission **336** can then be carried out by using another code rate. The invention lies particularly in the fact that these transmissions **334**, **336** with different code rates can be combined by using incremental redundancy.

FIG. **2** describes how the radio system of the invention can be implemented. The structure of a radio transmitter **260** is described on the left side of FIG. **2** and the structure of a radio receiver **264** on the right side of the figure. Only parts of the radio transmitter **260** and the radio receiver **264** that are essential for the invention are described.

The radio transmitter **260** comprises a channel coder **202** for channel coding a data block **270** into a coded data block by using a selected channel coding and for puncturing the coded data block by using a first puncturing pattern. The coded data block punctured by the first puncturing pattern is transmitted to a receiver by transmission means **204**. The transmission means **204** comprise a modulator modulating digital signals to a radio frequency carrier wave. The transmission means can further comprise filters and amplifiers.

The radio transmitter **260** comprises means **232** for receiving a retransmission request of the coded data block transmitted on a radio connection **250**. In order to receive the retransmission request, the radio transmitter **260** comprises a receiver, so the radio transmitter is, in fact, a transceiver.

The channel coder **202** increases the code rate of the coded data block to be retransmitted by puncturing the coded data block coded by the channel coding of the original transmission by using a second puncturing pattern that comprises fewer symbols to be transmitted than the first puncturing pattern. The transmission means **204** transmit the coded data block punctured by the second puncturing pattern to the receiver.

The radio receiver **264** comprises reception means **210** for receiving the coded data block channel-coded by the selected channel coding and punctured by the first puncturing pattern. The reception means **210** comprise a filter to block frequencies outside a desired frequency band. Next, the signal is converted to intermediate frequency or directly to baseband, in which form the signal is sampled and quantized at an analogue/digital converter. An optional equalizer compensates for interference, for example interference caused by multipath propagation.

A detected signal **212** is supplied to a channel decoder **218** decoding the received coded data block.

The radio receiver **264** comprises means **224** for detecting a need for retransmission of the received coded data block, and means **226** for transmitting the retransmission request of the coded data block to the transmitter **260** by using the radio link **250**. The means **226** are implemented by a common radio transmitter, so the radio receiver **264** is a transceiver.

The reception means **210** receive a retransmitted coded data block **220** whose code rate has been increased by puncturing the coded data block coded by the channel coding of the original transmission by using the second puncturing pattern. The second puncturing pattern comprises fewer symbols to be transmitted than the first puncturing pattern.

The radio receiver **264** further comprises means **222** for combining a received coded data block **216** punctured by the first puncturing pattern and the coded data block **220** punctured by the second puncturing pattern. The coded data block **216** originally received is thus stored in the memory of the receiver. The channel decoder **218** decodes the channel coding of the combined coded data block.

The invention is preferably implemented by software, whereby the method of the invention requires relatively simple software changes in a closely-defined area in the radio transmitter **260** and the radio receiver **264**. The channel coder **202**, the channel decoder **218**, the means **224**, **234** for processing retransmission requests and the means **222** for combining are preferably implemented as software, for

example as software to be executed in a general purpose processor. Implementation by hardware is also feasible, for example as application specific integrated circuit ASIC or as control logic constructed from separate components.

The cases described in the examples are basic cases; the invention disclosed in the claims also covers different combined cases, for example a case wherein the original transmission and a first retransmission are carried out using the same code rate, and a second retransmission is carried out using an increased code rate. Similarly, a case is also feasible wherein more than one retransmission is carried out by using an increased code rate, a combined coded data block then being generated from a desired number of received data blocks. The essential point for the invention only is that the combined coded data block is generated from at least two data blocks coded by different code rates.

Although the invention has been described above with reference to the example in accordance with the accompanying drawings, it is obvious that the invention is not restricted thereto but can be modified in many ways within the scope of the inventive idea disclosed in the attached claims.

What is claimed is:

1. A method of transmitting data in a radio system from a transmitter to a receiver, the method comprising:

channel coding a data block into a coded data block by using a selected channel coding;

puncturing the coded data block by using a first puncturing pattern;

transmitting the coded data block punctured by the first puncturing pattern to the receiver;

detecting a need for retransmission of the received coded data block;

transmitting a retransmission request of the coded data block to the transmitter;

increasing the code rate of the coded data block to be retransmitted by puncturing the coded data block coded by the channel coding of the original transmission using a second puncturing pattern including fewer symbols to be transmitted than the first puncturing pattern;

transmitting the coded data block punctured by the second puncturing pattern to the receiver;

combining the received coded data block punctured by the first puncturing pattern and the received coded data block punctured by the second puncturing pattern; and

decoding the channel coding of the combined coded data block.

2. The method of claim 1, wherein the symbols to be transmitted of the first puncturing pattern and the second puncturing pattern together comprising as many of the symbols of the coded data block as possible.

3. The method of claim 1, wherein the code rate of the punctured coded data block does not exceed 1.

4. The method of claim 1, wherein a combination of modulation and coding schemes used in an EGPRS in an original transmission and in a retransmission being one of the following:

modulation and coding scheme six and modulation and coding scheme nine,

modulation and coding scheme five and modulation and coding scheme seven, and

modulation and coding scheme six using padding bits and modulation and coding scheme eight.

5. A radio system comprising:

a transmitter and a receiver having a radio connection to the transmitter;

the transmitter comprising a channel coder for channel coding a data block into a coded data block by using a selected channel coding and for puncturing the coded data block by using a first puncturing pattern, and transmission means for transmitting the coded data block punctured by the first puncturing pattern to the receiver; and

the receiver comprising a channel decoder for decoding the received coded data block, means for detecting a need for retransmission of the received coded data block, and means for transmitting a retransmission request of the coded data block to the transmitter; wherein:

the channel coder increases the code rate of the coded data block to be retransmitted by puncturing the coded data block coded by the channel coding of the original transmission by using a second puncturing pattern comprising fewer symbols to be transmitted than the first puncturing pattern;

the transmission means transmit the coded data block punctured by the second puncturing pattern to the receiver;

the receiver comprises means for combining a received coded data block punctured by the first puncturing pattern and a received coded data block punctured by the second puncturing pattern; and

the channel decoder decodes the channel coding of the combined coded data block.

6. The radio system of claim 5, wherein the symbols to be transmitted of the first puncturing pattern and the second puncturing pattern together comprise as many of the symbols of the coded data block as possible.

7. The radio system of claim 5, wherein the code rate of the punctured coded data block does not exceed 1.

8. The radio system of claim 5, wherein the combination of the modulation and coding schemes used in EGPRS in an original transmission and in a retransmission is one of the following:

modulation and coding scheme six and modulation and coding scheme nine,

modulation and coding scheme five and modulation and coding scheme seven, and

modulation and coding scheme six using padding bits and modulation and coding scheme eight.

9. A radio transmitter comprising:

a channel coder for channel coding a data block into a coded data block by using a selected channel coding and for puncturing the coded data block by using a first puncturing pattern;

transmission means for transmitting the coded data block punctured by the first puncturing pattern to a receiver; and

means for receiving a retransmission request of the coded data block; wherein:

the channel coder increases the code rate of the coded data block to be retransmitted by puncturing the coded data block coded by the channel coding of the original transmission using a second puncturing pattern comprising fewer symbols to be transmitted than the first puncturing pattern;

the transmission means transmit the coded data block punctured by the second puncturing pattern to the receiver.

10. A radio receiver comprising:

reception means for receiving a coded data block channel-coded by a selected channel coding and punctured by a first puncturing pattern;

a channel decoder for decoding the received coded data block;

means for detecting a need for retransmission of the received coded data block; and

means for transmitting a retransmission request of the coded data block to a transmitter;

wherein:

the reception means receive the retransmitted coded data block whose code rate has been increased by puncturing the coded data block coded by the channel coding of the original transmission by using a second puncturing pattern comprising fewer symbols to be transmitted than the first puncturing pattern;

the reception means includes means for combining the received coded data block punctured by the first puncturing pattern and the received coded data block punctured by the second puncturing pattern;

a channel decoder decodes the channel coding of the combined coded data block.

* * * * *